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Direct/Delayed Response Project: Field Operations and Quality Assurance Report for Soil Sampling and Preparation in the Southern Blue Ridge Province of the United States. Volume 1.

Lockheed Engineering and Management
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The Direct/Delayed Response Project Soil Survey includes the mapping, characterization, sampling, preparation, and analysis of soils in order to assess watershed response to acidic deposition within various regions of the United States. Soil samples collected by sampling crews in the Southern Blue Ridge Province were processed at two preparation laboratories before being sent for analysis at four analytical laboratories. Volumes I and II summarize the procedural and operational compliance with protocols used by the sampling crews and by the preparation laboratories, respectively. Deviations from protocols and difficulties encountered are identified and discussed. Recommendations are made for program improvement.

In general, soil sampling activities during the survey proceeded as planned. A review of the soil data suggests that the integrity of the soil samples was maintained during the preparation activities. In most cases, sampling crews and laboratory personnel adhered to protocols.

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VOLUME I SAMPLING

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Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The Direct/Delayed Response Project is designed to address the concern over potential acidification of surface waters by atmospheric deposition within the United States. The Southern Blue Ridge Province soil sampling was conducted during the Spring of 1986 to provide soil samples for a synoptic physical and chemical survey to characterize watersheds located in a region of the United States believed to be susceptible to the effects of acidic deposition. A similar regional soil survey was conducted in the northeastern United States in 1985. This document describes the planning activities and summarizes field operations and quality assurance/quality control activities associated with soil sampling activities of the Southern Blue Ridge Province soil survey. A total of 125 routine and special interest pedons were described and sampled.

Before the regional surveys, a pilot study was conducted to develop and test site location protocols and sampling procedures and to assess logistical constraints associated with implementing these procedures. From this study, a sampling site selection algorithm was developed to select soil and vegetation classes for sampling activities in the regional surveys.

In general, soil sampling activities during the survey proceeded as planned. Observations, difficulties, and concerns are discussed in this report, and recommendations are made for modification and improvements. These recommendations may be valuable to planners of similar projects.

This report was submitted in fulfillment of contract number 68-03-3249 by Lockheed Engineering and Management Services Company, Inc., and contract number 68-03-3246 by Northrop Services, Inc., under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from March 1986 to December 1986, and work was completed as of October 1987.

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LIST OF ABBREVIATIONS

DDRP	Direct / Delayed Response Project
DQO	Data quality objective
EMSL-LV	Environmental Monitoring Systems Laboratory - Las Vegas, Nevada
EPA	U. S. Environmental Protection Agency
ERL-C	Environmental Research Laboratory - Corvallis, Oregon
FD	Field duplicate
GIS	Geographic Information System
NAPAP	National Acid Precipitation Assessment Program
NSWS	National Surface Water Survey
ORNL	Oak Ridge National Laboratory
QA	Quality assurance
QC	Quality control
RCC	Regional Correlator/Coordinator
SAF	Society of American Foresters
SCS	Soil Conservation Service

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SECTION 1

INTRODUCTION

OVERVIEW

The Direct/Delayed Response Project (DDRP) is an integral part of the acidic deposition research program of the U.S. Environmental Protection Agency (EPA). The EPA program is conducted under the federally mandated National Acid Precipitation Assessment Program (NAPAP) which addresses the concern over potential acidification of surface waters by atmospheric deposition within the United States. DDRP is administered by the EPA Environmental Research Laboratory in Corvallis, Oregon (ERL-C). M. Robbins Church is the DDRP Technical Director.

The overall purpose of DDRP is to characterize geographic regions of the United States by predicting the long-term response of watersheds and surface waters to acidic deposition. DDRP has been designed under the concept of regionalized integrative surveys. According to this concept, research programs initially are approached from a large region of study leading to the selection of regionally characteristic systems. These systems can be assessed through detailed, process-oriented research which will aid in the understanding of the underlying mechanisms responsible for observed effects. The projected responses of watershed systems typical of the regional population then can be extrapolated with confidence to a regional or national scale.

Two regions of the United States were selected for study: the Northeastern region and the Southern Blue Ridge Province (SBRP). In defining the regions of concern, the intent was to focus on regions (1) with surface waters that have low acid neutralizing capacity, and (2) that exhibit a wide contrast both in soil and watershed characteristics and in levels of acidic deposition.

EPA is assessing the role that atmospheric deposition of sulfur plays in controlling long-term acidification of surface waters (EPA, 1985a). Recent trend analyses have indicated that the rate of sulfur deposition is either unchanging or slowly declining in the northeastern United States, but is increasing in the southeastern United States. If a 'direct' response exists between sulfur deposition and surface water alkalinity, then the extent of current effects on surface water probably would not change much at current levels of deposition, and conditions would improve as the levels of deposition decline. If surface water chemistry changes in a 'delayed manner, e.g., due to chemical changes in the watershed, then future changes in surface water chemistry (even with level or declining rates of deposition) become difficult to predict. This range of potential effects has clear and significant implications to public policy decisions on possible additional sulfur emissions control (EPA, 1985b).

Specific goals of DDRP are (1) to define physical, chemical, and mineralogical characteristics of the soils and to define other watershed characteristics across these regions, (2) to assess the variability of these characteristics, (3) to determine which of these characteristics are most strongly related to surface-water chemistry, (4) to estimate the relative importance of key watershed processes in controlling surface-water chemistry across the regions of concern, and (5) to classify the sample of watersheds with regard to their response to sulfur deposition and to extrapolate the results from the sample of watersheds to the regions of concern.

A variety of data sources and methods of analysis will be used to address the objectives of DDRP. In addition to the data collected during DDRP, other data sources include the following data bases:

- National Surface Water Survey (NSWS)
- Acid Deposition Data Network (ADDNET), including GEOECOLOGY
- Soil Conservation Service (SCS) Soils-5
- Adirondack Watershed
- Topographic and Acid Deposition System (ADS) [total sulfur deposition data]
- U. S. Geological Survey [runoff data]

Also, data from EPA long-term monitoring sites, episodic event monitoring sites, and intensively studied watersheds will be used.

The data that are collected will be analyzed at three levels:

- Level I - System description and statistical analysis
- Level II - Single factor response-time estimates
- Level III - Dynamic systems modeling

Field and laboratory data collected in DDRP are included in the system description in Level I. These data also will be used in Level II to develop single factor estimates of the response time of watershed properties, e.g., sulfate adsorption capacity, to sulfur deposition. Finally, the data will be used in Level III, in conjunction with three dynamic simulation models, MAGIC (Cosby et al., 1984), ILWAS (Chen et al., 1984), and Trickle-Down (Schnoor et al., 1984), to predict the long-term regional watershed and surface water responses to sulfur deposition.

DDRP includes two major field activities: soil mapping and soil sampling. The mapping tasks were the responsibility of ERL-C. The soil sampling was conducted as a cooperative effort of two EPA laboratories under the management of the technical director at ERL-C. The soil sampling task leader at ERL-C had overall responsibility for the soil sampling including quality assurance/quality control (QA/QC) for the site selection, profile description, and sampling. Logistical support and preparation and analytical QA/QC support were provided by the EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV).

A QA program was developed to assure the validity of the profile description and sampling efforts for the DDRP soil survey. The integrity of the sampling activities affects the ultimate quality of data derived from physical, chemical, and mineralogical analyses of the samples. The QA program was designed to assess data quality so that potential users of the data may determine if the data meet their project needs. In addition, the QA program was designed to ensure that the resulting data are comparable within and across the regions of concern. Soils were described and sampled according to documented protocols (see Appendix A), although special interest watersheds were sampled by using slightly modified protocols (see Appendix C). Laboratory analyses were conducted according to documented protocols (Cappo et al., 1987).

FIELD OPERATIONS DOCUMENTATION

Volume I of the report documents field operations during the SBRP soil survey, and evaluates compliance with the protocols provided to the sampling crews. Deviations from the protocols are documented, data for profile descriptions are reviewed, and an evaluation is made of the potential effect of these deviations on the validity of the sampling and the integrity of the samples. In addition, this report recommends modifications to the sampling protocols that should be considered for future surveys.

This volume was primarily developed from the following sources of information:

- Documents referenced in this report
- Sampling log books
- Field data forms
- Photographic slides of each pedon sampled
- Audit reports by QA staff
- Sample receipt log books
- Project reports to EPA management (including DDRP Team Reports)
- Interviews with project participants
- Notes from the SBRP exit meeting

THE SOIL SURVEY

The SBRP soil survey included the area encompassing the Blue Ridge Mountains in eastern Tennessee, northcentral Georgia, western North Carolina, and northwestern South Carolina. Special interest watersheds sampled as part of this survey are located in the Coweeta Hydrologic Laboratory of the U.S. Department of Agriculture (USDA) Forest Service near Franklin, Macon County, North Carolina and in White Oak Run watershed in Rockingham County, Virginia.

The streams in this region were sampled in 1985 as part of the National Surface Water Survey, which is a NAPAP program designed and implemented by EPA to conduct a chemical survey of lakes and streams located in regions of the United States believed to be susceptible to the effects of acidic deposition. This program included the pilot National Stream Survey, which helped identify a target population within SBRP consisting of medium-sized streams draining watersheds of less than 200 square kilometers in area. A sampling design was applied to allow for unbiased characterization of regional populations, and resulted in the selection of 54 watersheds. In addition, seven special interest watersheds were selected.

Pilot stream survey watersheds encompassing areas less than 3,000 hectares were included in the soil survey. Of the 54 watersheds in the pilot stream survey, 35 watersheds satisfied this criterion, and were selected as the sampling frame for the SBRP soil survey. In addition, two of the seven special interest watersheds were included in the soil survey. The design of the soil survey is presented schematically in Figure 1.

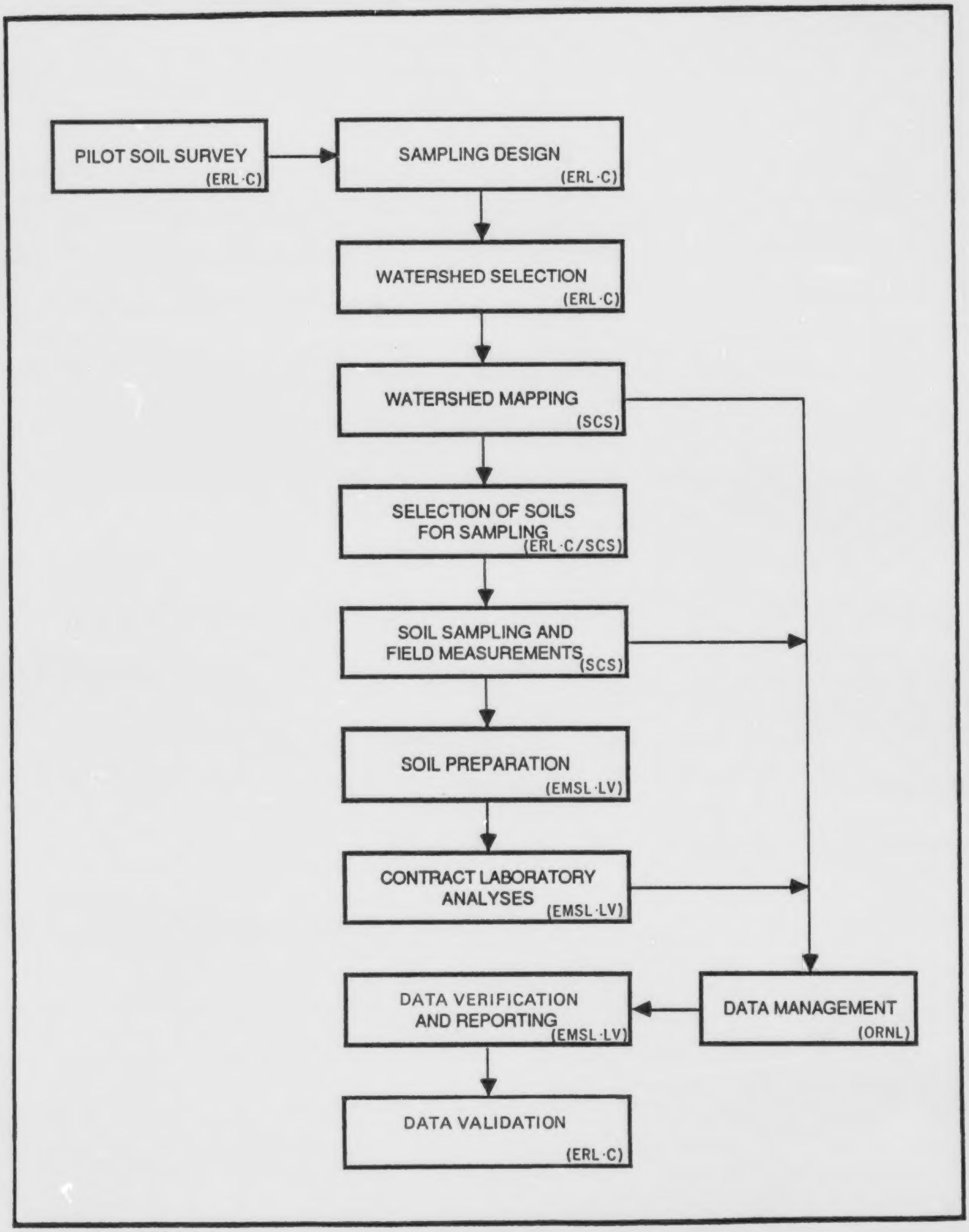

PILOT SOIL SURVEY
(ERL·C)
SAMPLING DESIGN
(ERL·C)
WATERSHED SELECTION
(ERL·C)
WATERSHED MAPPING
(SCS)
SELECTION OF SOILS FOR SAMPLING
(ERL·C/SCS)
SOIL SAMPLING AND FIELD MEASUREMENTS
(SCS)
SOIL PREPARATION
(EMSL·LV)
CONTRACT LABORATORY ANALYSES
(EMSL·LV)
DATA VERIFICATION AND REPORTING
(EMSL·LV)
DATA MANAGEMENT
(ORNL)
DATA VALIDATION
(ERL·C)

Figure 1. Design for the Direct/Delayed Response Project soil survey

Soil Mapping

Mapping was conducted primarily by SCS soil scientists under interagency agreements between EPA and USDA. In some states, SCS subcontracted cooperators at land-grant universities and private consultants, and temporarily hired other individuals for staffing the sampling crews. The objective of the soil mapping was to identify soil types occurring within the watersheds so that DDRP staff could group similar soils into sampling classes defined for the SBRP survey. Vegetation classes were noted in order to document the vegetation occurring in the watershed at the time of the survey.

On July 2, 1985, a planning workshop was held in Raleigh, North Carolina to define soil mapping activities and to meet with survey participants. A meeting was held in Atlanta, Georgia from August 21 through 28, 1985, to develop a regionally correlated soil legend and to discuss the modification and use of soil mapping protocols that had been developed for the Northeastern soil survey. A soil mapping workshop was held in western North Carolina from October 8 through 10, 1985, to review soil mapping protocols. Two days of the workshop were devoted to mapping and transecting practice employing the specified protocols.

Mapping for the SBRP soil survey was conducted from October 15, 1985, through May 23, 1986. The protocols used in mapping are detailed in Chapter 7 of the DDRP Action Plan/ Implementation Protocol (EPA, 1985b). A separate field operations report discusses mapping activities in SBRP (Lammers et al., in preparation).

Sampling Class Development

Initial criteria for the development of the sampling classes were as follows:

- Group similar soils so that the variability within a sampling class is less than the variability between sampling classes.
- Restrict the number of sampling classes that have limited occurrence in the watershed studied, i.e., that occur only in less than 5 percent of the watersheds.
- Restrict the number of sampling classes having a total mapping area of less than 200 acres, i.e., 83 hectares or about 0.2 percent of the overall area mapped in the region.

The final step was to identify sampling classes in specific watersheds for sampling. The sampling classes were selected to satisfy the following criteria:

- Characterize all sampling classes at similar levels of precision.
- Include the range in soil characteristics within each sampling class over the watersheds selected for sampling.

The definition of sampling classes was accomplished at the soil correlation and sampling class selection workshop held in Corvallis, Oregon, from March 3 through 7, 1986. The procedures developed to satisfy the sampling objectives are presented in the QA plan (Bartz et al., 1987). Sampling classes developed for use in the SBRP soil survey are provided in Figure 2.

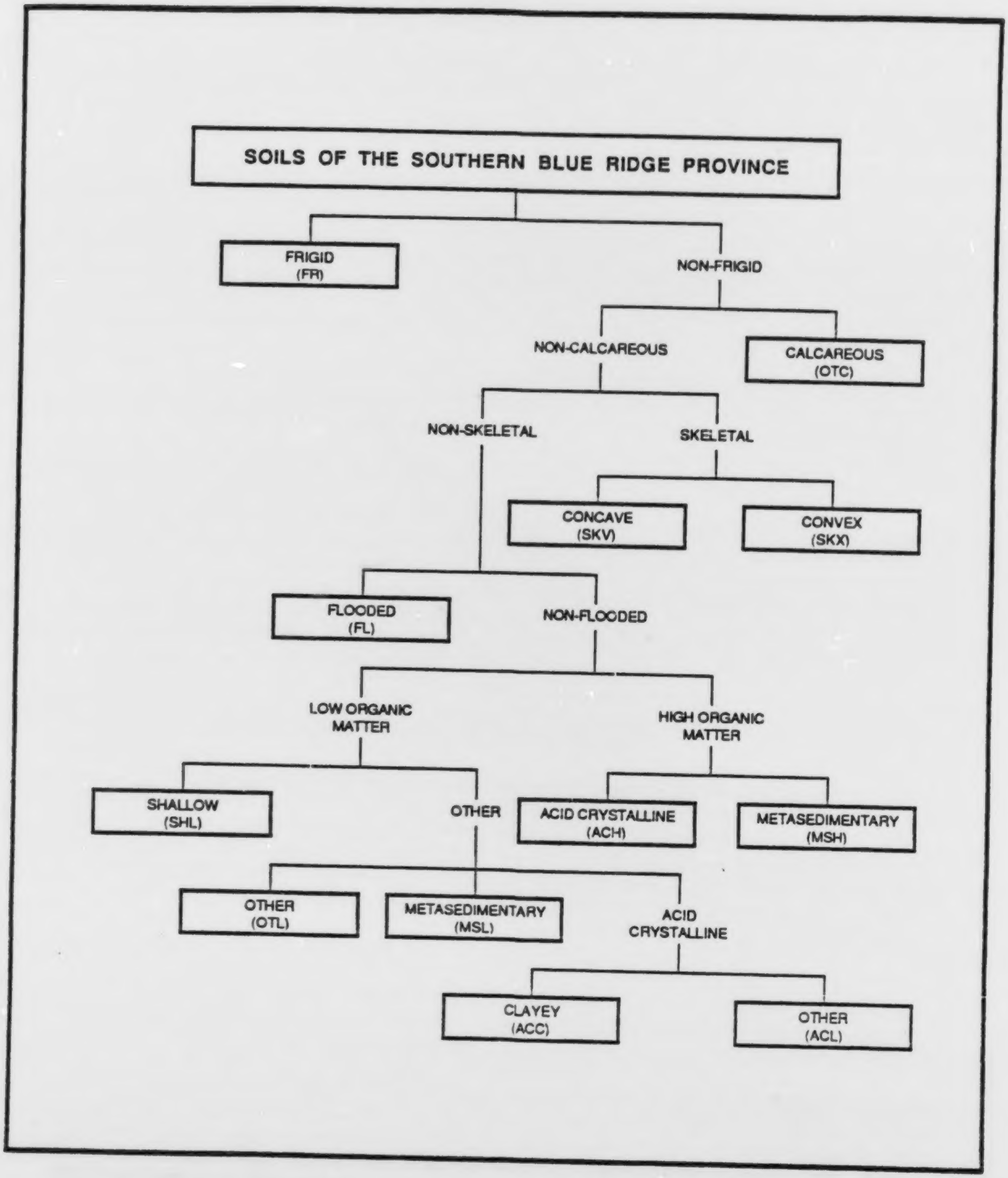

SOILS OF THE SOUTHERN BLUE RIDGE PROVINCE
FRIGID (FR)
NON-FRIGID
NON-CALCAREOUS
CALCAREOUS (OTC)
NON-SKELETAL
SKELETAL
CONCAVE (SKV)
CONVEX (SKX)
FLOODED (FL)
NON-FLOODED
LOW ORGANIC MATTER
HIGH ORGANIC MATTER
SHALLOW (SHL)
OTHER
ACID CRYSTALLINE (ACH)
METASEDIMENTARY (MSH)
OTHER (OTL)
METASEDIMENTARY (MSL)
ACID CRYSTALLINE
CLAYEY (ACC)
OTHER (ACL)

Figure 2. Sampling classes for the Southern Blue Ridge Province soil survey

Computer Program for Selection of Sampling Sites

The method of watershed and sampling class selection used in the SBRP is detailed in EPA (1985b). The algorithm for watershed and sampling site selection was applied using a personal computer programmed to obtain a list of possible sampling classes for each watershed. The subsequent steps were performed manually by ERL-C staff.

A watershed map with soil mapping units delineated by sampling class was used in conjunction with a 1-hectare square mylar grid overlay. Random coordinates were generated by a computer program and were located on the grid. If the resulting point did not fall within a soil mapping unit containing the sampling class chosen for that watershed, then another random coordinate point was generated. If the point fell on a mapping unit that was a soil complex, a random procedure was used to ensure that the probability of accepting the point was approximately equal to the proportion of the sampling class within the complex.

This process was repeated until five random points located within mapping units containing the correct sampling class were designated in the watershed. The points were numbered 1 through 5, in the order of selection, and were plotted on the base map. In addition, a vegetation class associated with the sampling class was defined for each point. Copies of the resulting maps and lists of the assigned sampling and vegetation classes were given to the SCS for site selection purposes.

The method for sampling site selection as described above presented difficulties when applied to sampling classes that occur as a long, narrow component on the landscape. For these sampling classes, fifty or more random coordinates often were generated before five points were located within the area of the sampling class. Therefore, a second selection method was developed to reduce the time required to choose five points while satisfying the requirements for a random selection. This second method involved the following steps: (1) overlaying the 1-hectare mylar grid on the watershed map; (2) numbering all points that fell into mapping units contained in the selected sampling class consecutively from 1 to n; (3) defining the appropriate random number window size, which was dependent on the number of points in the sampling class delineations; and (4) selecting sampling sites 1 through 5 using a five-digit random number table.

For cases in which soil complexes were under consideration for sampling, an additional keep/reject criterion was applied. Usually the final two, or occasionally three, digits were used for the selection process. However, in complexes, using the occurrence of the sampling class within the mapping unit to the nearest 10 percent as an index, the sampling point was incorporated as a selected site only if the occurrence was greater than or equal to the first digit of the random number. The point was rejected as a sampling site when the occurrence was less than the random number.

Field Selection of Sampling Locations

The sampling crews used the watershed base map and the protocols (Appendix A) to determine the sampling locations. This system assured a high probability for locating a point within the designated sampling class and vegetation class.

The procedure for specifying the order in which the five randomly chosen coordinates were to be visited was modified from the procedure used for the Northeastern soil survey. In the Northeastern soil survey, the coordinates were labeled 1 through 5 in the order in which they were selected. This order was specified as the order in which the sites were to be visited by the sampling crew. In the SBRP soil survey, the first randomly chosen site was the first site the sampling crew was to visit. The remaining four points were visited in order of increasing distance from the first point. This modification was made for the convenience of the sampling crews, and did not affect the validity of the sampling scheme (DDRP Team Report No. 16, March 17, 1986).

Routine soil sampling conducted by the SCS characterizes soils on the landscape by using descriptive soil series characteristics based on a non-random, highly selective sampling design. The DDRP soil survey differs from this routine in that DDRP sampling is based on the random selection of sampling locations within a region of concern. This experimental design, i.e., random sampling of pedons, allows derivation of statistically valid inferences concerning watershed responses to acidic deposition.

To fulfill the data requirements for calibration of the acid deposition response models, sampling sites in special interest watersheds were not selected randomly. Instead, the sampling crew was sent to a specified point and instructed to sample a soil that was intended to represent the specific watershed or portion of the watershed from which it was obtained.

Coordination of Sampling Activities

Weekly conference calls between SCS and EPA staff were used to discuss and resolve matters involving sampling protocols and site location difficulties, as well as to review the status of sampling operations and to identify access difficulties, e.g., the need for a helicopter to access a watershed. In addition, the conference calls also provided regular communication to ensure that all SCS staff were informed of protocol modifications and issues of concern. Major issues resulting from these discussions were documented in the DDRP team reports by the soil sampling task leader.

Exit Meeting

Following the SBRP soil sampling activities, an exit meeting was held July 15 through 17, 1986 in Park City, Utah. Meeting participants included SCS staff from from Georgia, North Carolina, Tennessee, and Virginia; representatives from the sampling crews; ERL-C DDRP staff; and representatives from Northrop Services, Inc. (technical and support staff for ERL-C), Lockheed Engineering and Management Services Company, Inc. (technical and support staff for EMSL-LV), Oak Ridge National Laboratory (ORNL), and Tetra Tech, Inc. A representative of the West Virginia SCS state office staff attended to obtain background information for possible DDRP soil survey activities in the Mid-Appalachian region.

SECTION 2

FIELD OPERATIONS

ERL-C staff were responsible for the overall management of the mapping and sampling during the SBRP soil survey. EMSL-LV staff were tasked with overseeing the preparation laboratories, procuring equipment and supplies, developing sampling protocols, and providing QA support. A discussion of all field activities follows.

PREPARATION FOR FIELD OPERATIONS

Procurement of Equipment and Supplies

A detailed listing of equipment and supplies is presented in Appendix A. Most of the materials were provided by EPA, although SCS personnel used their own equipment and supplies in some cases. Before procurement, cost estimates were obtained from at least three suppliers. The overall cost, shipping charges, and ability to deliver within the required time frame were considered prior to the initiation of a support contractor purchase request for each item. For some specialty supplies, e.g., clod storage boxes, a sole source justification was required.

Equipment and supplies were shipped to the preparation laboratories via air courier, and the preparation laboratory personnel distributed the materials to the sampling crews. Other specialized equipment was supplied directly to SCS personnel by ERL-C staff. Occasional delays were encountered in the shipment and delivery of equipment to the laboratories.

Protocol Development

Detailed protocols were based upon SCS National Cooperative Soil Survey procedures that were modified in order to accomplish the specific objectives of the DDRP soil survey. Procedures for sampling and describing soils are presented in Appendix A.

The routine site selection protocols were slightly modified for the special interest watersheds (see Appendix C). These modifications were necessary because of the intended use of the data for model testing and calibration. Protocol modifications for site selection of the special interest watersheds resulted in the collection of representative, but not random, samples.

Sampling Crew Training

EPA personnel involved in the sampling effort, SCS personnel, and others contracted by the SCS participated in a sampling workshop in Knoxville, Tennessee, from March 18 through 20, 1986. The purpose of the workshop was to review the sampling protocols (Appendix A), to become familiar with the field data forms and codes used for pedon description, and to participate in a field exercise applying the specified protocols. Many protocol questions, particularly sample labeling, were discussed. Set ID numbers, unique numbers that are used to identify all pedons collected by a sampling crew on a given day of sampling, were assigned for each sampling crew.

Protocol Modifications

An addendum to the protocols for routine sampling (Appendix B) was distributed before sampling activities began. Most of these modifications were identified during the training workshop.

Procedures were field tested during the first few weeks of sampling, and some modifications were suggested. This review subsequently resulted in editorial changes and the following modifications:

- In some cases it was found that pacing distances through forest, rhododendron thickets, or rugged terrain was not practical. It was decided that sampling crews could locate their starting point on the aerial photograph and could proceed to that point by any practical means. The distance from the starting point to a suitable landmark could then be scaled from the topographic map and entered on the field data form.

- Sometimes a mapped soil did not fit the prescribed sampling class. For example, the Brevard series is listed as class ACL (acid crystalline parent material, low organic matter); however, some soils mapped as Brevard occur on a metasedimentary parent material. In this case, the correct sampling class is MSL. This ambiguity was considered in developing the following guidelines:

  - When a soil in the field could be identified as one of the soils listed in the protocols, the list took precedence over the flowchart for defining sampling classes. If the soil was not included on the list, then the flowchart was used.

  - When the soil was sampled because it was in the designated sampling class according to the list, but the flowchart indicated that it fit better in a different sampling class, this was noted on the field data form.

- The protocols were not clear as to whether or not additional sets of clod samples should be collected for the field duplicate samples. It was decided that the collection of duplicate sets would yield little new information and was not required.

- The protocols do not provide instructions for labeling samples from horizons that have been split-sampled because of contrasting soil material. For example, a B/C horizon would be predominantly B material with pockets or strata of C horizon material. Sampling crews were instructed to sample the B and C material separately. A problem occurred when sampling crews assigned the same sample number to B and C material samples. The samples should be identified as unique samples by using different sample codes.

Additional Training

Sampling crews received additional training before sampling began. All crews participated in training sessions organized by their respective SCS state staffs. The regional correlator/coordinator (RCC) was present for the session held in Georgia on April 14, 1986, and for the session held in Tennessee on April 1, 1986. The RCC spent April 3, 1986, with North Carolina crews. North Carolina sampling crews spent 3 or 4 days together sampling practice pedons to gain familiarity with the protocols.

Special Interest Watershed Sampling

Five pedons each were sampled from Watershed 34 and Watershed 36 in the Coweeta Hydrologic Laboratory area by sampling crew NC03, assisted by members of sampling crew NC01. Five pedons were sampled in the White Oak Run special interest watershed by sampling crew VA01. This crew did not participate in routine soil sampling, although the VA01 crew leader did accompany crew NC03 during sampling of the Coweeta watersheds from May 19 through 23, 1986. Also, the RCC participated with VA01 in the sampling of the first site in White Oak Run on June 18, 1986 and was in the watershed as the other sites were sampled during the period from June 17 through 20, 1986 (RCC, personal communication, October 26, 1987).

SOIL SAMPLING

Soil sampling operations cover a wide range of activities including site location, pit excavation, photographic documentation, pedon description, and soil sampling. Sampling protocols and modifications for routine sampling are described in Appendices A and B, respectively; protocols for special interest watersheds are documented in Appendix C. The following sections discuss issues associated with the implementation of the protocols. Recommendations also are presented to modify and improve the protocols for use in future regional soil surveys.

Sampling activities were initiated during the week of April 2, 1986, in North Carolina and Tennessee and during the week of April 15, 1986, in Georgia. All 110 routine pedons had been sampled by June 16, 1986. This met the target date for completion of sampling. Special interest watersheds were sampled from May 13 to June 22, 1986. A summary of soil sampling activities is provided in Table 1.

TABLE 1. SUMMARY OF ROUTINE SOIL SAMPLING DURING 1986

	Number of Pedons		Dates of Sampling	
SCS Staff	Designated	Sampled	Initial	Final
GA	37	37	4/15	6/12
NC	45	44	4/2	6/6
TN	32	29[a]	4/2	5/22
TOTAL	114	110[b]		

a Two pedons were added to the sampling list for Tennessee.

b Two pedons were eliminated from the original sampling list, and inadvertently two pedons were not sampled (see Table 2).

Site Selection and Site Restrictions

One of the initial responsibilities of the sampling crew leader was to assess sampling site locations. The watershed maps provided by EPA were reviewed to determine the physical accessibility and land ownership status , i.e., public or private, of each site.

Physical Inaccessibility--

Sites were defined as physically inaccessible if all alternatives for approaching the site were eliminated or if the site was under water. Helicopter support was available for difficult sites, although National Park Service regulations restricted the use of helicopters within The Great Smoky

Mountains National Park. Permission to sample within the park was granted with the cooperation of the National Park Service, the Tennessee SCS, and EPA.

Most sampling points were accessible. If there were too many trees for landing a helicopter, the sampling crew could hike to the sampling site, and a helicopter could be used to transport supplies to the watershed and to retrieve supplies and samples from the sampling sites.

Helicopters were used to access the Eagle Creek and Forney Creek watersheds in The Great Smoky Mountains National Park. At the exit meeting, sampling crews mentioned that some samples were lost during the original airlift from Forney Creek. However, the pedon was resampled (E. Lewis, personal communication, October 19, 1987).

Sampling crew TN01 considered the first four points specified for pedon 2A0-7811 to be inaccessible because, even with helicopter support, the time required to hike to the sites and to sample exceeded a reasonable working day. The fifth point satisfied sampling site requirements.

Denied Access--

There were occasional instances of access to SBRP sampling sites being denied by private landowners. Because of a government announcement during April 1986 that a site for nuclear waste storage was under study near Asheville, North Carolina, landowners occasionally were suspicious of field crews working in the vicinity. Some crews mentioned that a letter on EPA letterhead explaining the sampling activities to the landowner would have been helpful in this situation.

Inappropriate Site Conditions--

In the Northeastern soil survey, occasionally a pedon was disqualified from sampling because of conditions observed at the site. These conditions included flooding or severe disturbance, such as parking lots or housing developments built on fill. Such conditions were considered inappropriate for a regional characterization of soils according to DDRP objectives. In the SBRP soil survey, no pedons were disqualified from sampling for this reason. Also, no instances were noted where all possible sampling points for a pedon were eliminated.

Site Restrictions on Sampling Class--

Initially, 114 pedons were selected for the SBRP soil survey. Four pedons were eliminated because the designated sampling class was not found during the site selection process. In addition, four pedons were sampled from sampling classes that were different from those initially specified. A summary of the pedons removed from or modified on the sampling list is provided in Table 2.

Only one of those four pedons that were not sampled, i.e., sampling class SKV on watershed 2A0-7703, was eliminated because the sampling class selection was based on incorrect mapping data which later were rectified. For the other three pedons, i.e., sampling class OTL on watershed 2A0-7821 and sampling class OTC on watersheds 2A0-7701 and 2A0-7805, the crews had been asked to sample where the designated sampling class occurred as an inclusion for the mapping unit. However, in these cases, the inclusion did not occur in the delineated mapping unit.

Two of the four pedons sampled in a sampling class other than that initially specified were located on inclusions to the soil mapping unit. To compensate for not finding the sampling class OTC on two designated watersheds, two additional OTC samples were requested from watershed 2A0-7803. In each case, the sampling crew understood that the request was to substitute sampling class OTC for the sampling classes MSL and SKX originally designated for this watershed. (Additional discussion of sampling class OTC occurs later in this section.)

TABLE 2. PEDONS REMOVED FROM OR MODIFIED ON THE SAMPLING LIST

Watershed ID	State	Sampling Class	Reason
2A0-7701	TN	OTC	Required sampling class not found
2A0-7703	TN	SKV	Required sampling class not found
2A0-7803	TN	MSL	Sampled OTC instead
2A0-7803	TN	SKX	Sampled OTC instead
2A0-7805	TN	OTC	Required sampling class not found
2A0-7811	GA	SKX	Changed to SKV
2A0-7821	NC	OTL	Required sampling class not found
2A0-8803	GA	SKV	Changed to SKX

Two other pedons intentionally were sampled in classes other than originally specified after it was discovered that sampling classes SKV and SKX had been interchanged on two watersheds during the selection of watersheds for sampling. This resulted from a misinterpretation of mapping unit components, not from any deficiency in mapping.

There was a question raised during sampling concerning the sampling of soils in mapping units where the desired sampling class occurred only as inclusions. The issue was raised because a mapping unit, which did not include the designated sampling class ACL as a named component but did contain 25 percent of sampling class ACL as inclusions, was selected as a potential sampling site on watershed 2A0-7826-NC. It was decided that such mapping units could be sampled if the following criteria were satisfied: (1) the mapping units contained inclusions that fit the selected sampling class, (2) the sampling class made up at least 20 percent of the mapping unit, and (3) a pedon meeting the constraints of the sampling class could be located. The reason for deciding to sample such inclusions was that there were other mapping units, i.e., complexes, for which the sampling class made up only 20 percent and were automatically eligible for sampling. Because the sampling class occurred as a single soil series, it qualified as a named component of the complex. The original intent was to base sampling class selection on the occurrence of a sampling class within a mapping unit, without regard to whether or not the sampling class occurred as one or more named components of the mapping unit.

An exception to the DDRP minimum occurrence guideline was made for sampling class OTC which contains calcareous soils that occur only as inclusions. These soils comprised a sampling class because the occurrence of even small areas of calcareous soils could be important for determining the response of a watershed to acidic deposition.

Vegetation Class Considerations--

Vegetation classes were determined from data obtained during the watershed mapping phase. Vegetation classes recorded while mapping were identified using Society of American Foresters (SAF) cover types (Eyre, 1980); however, vegetation classes specified for the soil survey were based on an aggregation of SAF cover types. In some cases the cover types selected from the mapping could not be found at the site during the sampling. Discrepancies were attributed to the method used to group mapping units into sampling classes, mapping error, or vegetative changes at the site between the time of mapping and sampling. This difficulty occurred for only one watershed in the

SBRP soil survey: for watershed 2A0-8904, all sampling points were in the mixed vegetation class instead of the designated hardwood class. Permission to sample under a mixed vegetation canopy was obtained from EPA before sampling.

It should be noted that the vegetation at a sampling site might be nominally different in terms of percentage from the specified vegetation class and still fit the class. This is because the actual vegetative components were not always pure for a given vegetation class, e.g., a conifer class could contain up to 20 percent inclusions of hardwoods and still meet the criteria of the class. Sampling crews were instructed to consider vegetation located in the immediate vicinity of the site in order to meet suitable sampling criteria. Comments made at the exit meeting indicated that this assessment was not performed consistently by all sampling crews, i.e., some crews considered only the vegetation directly above the point to be sampled; other crews considered only the vegetation within a short radius of the point to be sampled.

Sampling crew leaders suggested during the exit meeting that the protocols should define the size of the area to consider and should provide guidelines to assess the composition of vegetation at the sampling site. Sampling crews commented that the SAF cover types were not always representative of the vegetation classes in this region.

Protocol Adherence--

Generally, all sampling crews adhered to the site selection protocols. Minor protocol deviations, noted in the sampling crew log books and the written QA audit reports, are discussed in later sections.

The GA01 crew did not initially use the method specified in the protocols for collection of the field duplicate sample, i.e., sequentially placing alternate trowelsful of soil into two containers. During a QA audit, the crew collected and mixed a 2-gallon sample and split it for the routine and field duplicate samples. In this scenario, the resulting samples would be field splits rather than field duplicates as was specified. For the SBRP soil survey, the design of the QA program is dependent upon data from the field duplicates rather than from field splits to estimate the sampling error.

Sampling Difficulties Relating to Soil Characteristics

No major difficulties relating to soil characteristics were encountered during sampling. Some soils with high water tables were sampled, and pumps or bailers were used to control seepage. In one case, the sampling crew encountered a water table at 0.5 meter. The crew attempted to sample, but had to abandon that particular pit. A different sampling site was chosen according to the site selection protocols.

Equipment for Pedon Description and Sampling

The success of pedon excavation and description, photographic documentation, clod sampling, sample storage and transportation, and other field activities was dependent on the equipment supplied to the trained sampling crews. The immediate availability of equipment to the sampling crews was an important factor. The utility, reliability, durability, and efficiency of the equipment had a major effect on the quality of sampling.

Equipment supplied to SBRP sampling crews, but not originally supplied for the Northeastern soil survey, is as follows:

- Hand pumps
- Canon Sure-Shot cameras (supplied to GA and NC sampling crews only)
- Khaki measuring tape for scale in the pedon photographs
- Photogray cards
- Clod tags for clods and boxes

Photographic Equipment--

Canon Sure-Shot 35-mm cameras were supplied to seven of the nine sampling crews. These cameras had been used previously for the National Surface Water Survey field work and were missing the operating instructions. Occasionally, batteries were not supplied with the cameras, and one camera was inoperable. Although this type of camera had been recommended for use following the Northeastern soil survey, its performance was comparable to other 35-mm cameras.

Participants in the Northeastern soil survey had suggested that ASA-400 film would produce better exposures. Both ASA-400 and ASA-200 film were used in the SBRP soil survey. Sampling crews determined that ASA-200 film was better for the range of field conditions encountered in the SBRP soil survey. The photogray cards used to identify sampling sites were too small to be legible in the exposures, and the colored golf tees used for delineating soil horizon boundaries were difficult to see. The scaled measuring tapes with black markings also were somewhat illegible in most of the slides.

Indelible Markers--

Indelible ink markers were supplied to the sampling crews for filling out labels and clod tags. The markers were indelible on the labels, but smeared on other surfaces. Therefore, the sampling crews purchased other types of indelible markers to replace those supplied.

Hand Pumps--

Portable hand pumps were supplied to most sampling crews. It was discovered that the discharge hose on the pump was too short to be effectively used in a soil pit 2 meters in depth, hence, sampling crews had to purchase longer discharge hoses. Also, sampling crews requested that repair instructions be supplied with the hand pumps. The pumps tended to clog frequently, and the sampling crews speculated that a filter would decrease clogging if it could be used with the pump.

Field pH Kits--

A standard pH kit that included fresh reagent was not supplied, therefore, comparison of field pH values among sampling crews is difficult. Sampling crews used their own field pH kits.

Boxes and Hair Nets for Clod Sampling--

Some sampling crews received used clod boxes that lacked dividers. Hair nets were in short supply for some sampling crews because of occasional irregularities in distribution.

Saran Solution for Coating Clod Samples--

When asked to do so, the preparation laboratories mixed the saran-acetone solution used to stabilize clod samples collected for the determination of bulk density. Health and safety considerations require that saran be mixed under a fume hood. Sampling crews cannot be expected to have ready access to fume hoods and should not be tasked with mixing their own saran.

Requests for Additional Equipment--

Sampling crews requested that paper punches, grass clippers, and digging bars be supplied as standard equipment. The paper punches were used for preparing clod tags. The grass clippers were used to trim the clod samples and to smooth the face of the profile before description. The digging bars were used during pit excavation.

Sample Labeling Discrepancies

Sampling crews delivered the soil samples to the preparation laboratories at regular intervals. Instead of copying information directly from the sample bag labels, i.e., Label A, it appears that some crews transcribed the sample codes from their sampling log books or field data forms without verifying that one sample was delivered for each corresponding sample code entry in the sample receipt log book.

Preparation laboratory personnel were responsible for verifying Label A data and for relabeling subsamples with Label B for shipment to the analytical laboratories. It was envisioned that preparation laboratory personnel would identify and correct mislabeled samples, although no provision was made in the protocols to provide copies of the field data forms to the laboratories. The identification of labeling or log book errors was delayed until copies of the field data forms were received.

Preparation laboratory personnel and EPA staff discovered occasional sample labeling errors after samples were placed in cold storage. These are summarized below:

- Two sets of samples (one collected by sampling crew TN01 and one collected by sampling crew NC01) were found to have the same sample ID number. Apparently TN01 labeled the sample bags with NC17-3007 for one pedon, and the accompanying field data form as NC17-3001. However, NC01 had previously used the sample ID NC17-3001. The issue was resolved by changing the number on TN01's field data form from NC17-3001 to NC17-3007. This differentiated the two samples and did not require relabeling the samples.

- Fourteen pedons from watersheds in North Carolina were found to have duplication in the use of sample ID numbers. The duplicated sample IDs and associated sampling classes are as follows:

  - NC089-01xx; SHL, OTL
  - NC089-02xx; ACC, SKV
  - NC089-03xx; ACL, ACH
  - NC089-04xx; ACL, ACH
  - NC087-01xx; ACL, FR
  - NC087-02xx; ACH, SKX
  - NC087-03xx; FR, MSL

Seven of the fourteen pedons subsequently received new sample numbers, as follows:

Old Sample Number	Sampling Class	New Sample Number
NC089-01xx	SHL	NC089-05
NC089-02xx	SKV	NC089-06
NC089-03xx	ACH	NC089-07
NC089-04xx	ACH	NC089-08
NC087-01xx	FR	NC087-04
NC087-02xx	SKX	NC087-05
NC087-03xx	MSL	NC087-06

* Two samples collected by GA01 had the same sample ID, but the soil color in the two sample bags was markedly different. The preparation laboratory treated these as two different samples. This was a result of using the same sample code for the B material and C material that were collected separately from a B/C horizon.

* Duplicate sample numbers were used for two pedons on Cosby Creek watershed, 2A0-7805. It was discovered that the sampling class labeled OTC was changed to FR. The sample code for this pedon was changed from TN029-03 to TN029-04.

* Samples with the sample code TN029-01 and the watershed ID 2A0-7891 were logged at the Tennessee preparation laboratory. The samples were subsequently incorporated into Batch 20603, which was sent to the analytical laboratory and was analyzed. Concern arose because no field data form was received for these samples and because this watershed ID was not listed for sampling. Later it was discovered that these samples were practice samples collected by the Tennessee SCS, and that they were submitted at the laboratory's request for use as practice samples. Although taking practice samples or using them in the preparation laboratory is not discouraged, such samples should not be assigned sample codes or be logged in the sample receipt log book.

* Three special interest watershed sample codes were recorded incorrectly by VA01. The preparation laboratory was directed to correct the codes after the errors were discovered.

Clod Sampling for Determination of Bulk Density

Sampling crews were instructed to collect three clod samples from each horizon if it were physically possible to obtain them and to prepare clods by immersing them in a 1:7 saran-acetone solution, by weight. In addition, sampling crews were instructed to record the number of times each clod was dipped into the saran-acetone mixture, if it were dipped more than once. This information was needed by the preparation laboratories to determine the weight of the saran coatings for use in the bulk density calculations.

The clod sampling procedure can be complicated by horizon thickness, soil structure and consistence, cohesion/adhesion properties, soil texture, root density, and the field moisture content of the soil. The projected success rate for clod collection was only 50 percent because it was anticipated that some horizons would be difficult to sample. Although clod sampling data were to be recorded on the field data forms, some sampling crews did not provide the data. On the basis of information from the preparation laboratories, the actual success rate for excavating clods from mineral soil horizons was 61 percent.

The number of saran coatings was recorded routinely on the clod labels and in the sample receipt log books. The duration of clod immersion in the solution did not vary widely among the crews. One sampling crew mixed a weak 1:56 saran:acetone solution for coating clods from pedons NC113-01 and NC113-02. This mixture was not sufficient to stabilize the clods, and most of them disintegrated during transport and storage.

Sample Transport and Storage

Samples were required to be placed in cold storage at 4°C within 24 hours after sampling. As previously mentioned, some sampling crews rented cold storage facilities near the sampling sites and stored samples until delivery to the preparation laboratory could be made at the end of the week. This system was used in the Northeastern soil survey and was found to be efficient. Samples were stored in the styrofoam coolers during transport to the preparation laboratory.

Preparation Laboratory Interactions

The services of two preparation laboratories were obtained through interagency agreements. The laboratory locations and sampling crews assigned to each laboratory are as follows:

Preparation Laboratory	Crew Assignments
University of Tennessee Department of Agronomy Knoxville, Tennessee	GA02, TN01, TN02, NC03, VA01, NC01
Clemson University Department of Agronomy Clemson, South Carolina	NC01, NC02, NC04, GA01

Preparation laboratory staff were responsible for storing samples received from the sampling crews, preparing soils for analysis (i.e., drying, sieving, and shipping samples to the analytical laboratories), determining the percentage of rock fragments, testing for the presence of carbonate, and determining the bulk density of clod samples. In addition, preparation laboratory staff initially distributed field equipment and supplies, received requests from the sampling crews for additional equipment and supplies, and inventoried the equipment returned by the sampling crews at the end of the sampling effort.

Interagency agreements with the preparation laboratories were not in place when soil sampling was initiated. Nevertheless, both laboratories provided cold storage space for soil samples, although the laboratories were hesitant to make expenditures, e.g., hiring laboratory personnel, until funding was assured. As a result, the preparation laboratories were not able to provide full logistical support as planned by DDRP staff. Both laboratories began operations after the interagency agreements were in place, although neither laboratory received payments until June 1986. (Note: Routine soil sampling was completed on June 16, 1986.)

Delivery of samples often could not be arranged during conventional work hours. Samples usually were delivered to a preparation laboratory by the sampling crew after a long day in the field, at the end of a week, or on the weekend. Laboratory personnel were required to check the labels of incoming samples against the sample codes recorded in the sample receipt log book. This was done as soon as possible to ensure that sample sets were complete and labels were filled out properly. Occasionally, the laboratory staff were able to inventory the samples while a sampling crew member was present.

Weekly conference calls between QA staff and preparation laboratory personnel aided in the distribution of supplies and equipment, resolved issues requiring the assistance of DDRP management staff, and allowed laboratory personnel an opportunity to share information. After soil sampling was completed and soil processing was well underway, it was decided that weekly conference calls were no longer necessary. Subsequent calls were made as needed.

Details of the preparation laboratory activities can be found in Volume II of this report, under separate cover (Haren and Van Remortel, 1987).

Field Data Forms and Codes for Pedon Descriptions

A standard SCS field data form was first adopted for DDRP use in the Northeastern soil survey. That survey involved the first widespread usage of the form by SCS soil scientists, and SCS was interested in working with EPA to modify the form for use in the SBRP soil survey. Changes to the form included placing the codes directly on the form for easy reference and restructuring the format. An attempt was made to create a generic form that could be used in any region of the United States. In general, the sampling crews responded favorably to the modified field data form and indicated that it was an improvement over earlier versions of the form. Appendix C of the protocols (contained in Appendix A of this document) provides a brief discussion on completing the field data form.

No major difficulties were encountered in filling out the field data forms. Audit reports indicated that a number of the sampling crews drafted a final version of the field data form derived from a rudimentary version that had been completed on-site. The intended protocol was to use the field data forms to document activities as they occurred, without regard for generating a second, neater copy. This was not always practical because the initial horizon designations and descriptions often were adjusted during sampling and transcription errors occurred that required insertion of correct data.

QA staff reviewed the forms to identify discrepancies, and subsequently the data were corrected by the SCS state staffs or by the sampling crews. SCS state staff noted that the following types of errors were made in completing the field data forms:

- Duplicate sample numbers in the same county.
- Pedon classification in error.
- Failure to indicate paralithic with a "w" when a Cr horizon occurred.
- Moist consistence recorded in the top block instead of the middle block.
- Horizon notes written in a form too abbreviated for computer operators to understand.
- Decimal points used in the pH field, i.e., 4.5 was entered rather than 045.
- Ochric epipedon not entered with an "o."

A modification requiring that a volume estimate of rock fragments in the 20- to 76-mm, 76- to 250-mm, and greater than 250-mm size fractions was made (DDRP Team Report No. 15, February 14, 1986). It later was determined that the 20- to 76-mm size fraction was not being estimated directly, i.e., the sampling crews were subtracting the 2- to 20-mm size fraction from the 2-to 76-mm fraction rather than performing the specific 20- to 76-mm volume estimate. The procedure for making this additional volume estimate was not provided in the protocols.

Structural modification of the field data form was intended to produce a generic form for use in all regions of the United States. As a result, it contains entry fields and codes that are not necessarily pertinent to conditions observed in the SBRP soil survey. The generic nature of the field data form occasionally resulted in a lack of codes describing specific situations observed in the SBRP watersheds.

Entry of Field Data

An interactive software program was developed by Oak Ridge National Laboratory to allow the input of field data and a hard-copy output of the data in an organized format. The hard copy was used by the SCS state staffs to check the field data before submitting the field data forms to ORNL for data entry.

Instructions for entering field data for horizons that were split for sampling because of thickness (more than 30 centimeters thick in upper meter of profile and more than 50 centimeters thick below one meter) caused some difficulties in data entry using the software. The sampling crews had been instructed to record "same" on the field data form for the lower part of a split horizon. It became necessary for data entry staff to add the missing values because the software program would not proceed unless values were entered in each entry field. The output for the lower part of the horizon is exactly the same as that for the upper part. Because there was no indication of a split sample, each part is displayed as a discrete horizon, which is misleading.

There were no instructions provided to the SCS state staffs concerning the entry of multiple, independent descriptions of the same pedon by sampling crew, state staff, and RCC. Because the descriptions were made at the same site, the field data forms contained the same ID codes. The North Carolina SCS produced two data files, one for crew data, and one for SCS state staff data. The Georgia SCS used "dummy" ID codes to differentiate the two descriptions.

The current software program does not allow entry of data contained in the "Log" field. These data specify which of the five possible points in the watershed was sampled and the exact location of the pedon sampled. If the new identification codes are implemented for future surveys and the software is modified to accommodate the changes, this difficulty will have been resolved.

SECTION 3

QUALITY ASSURANCE PROGRAM

EPA has mandated that the Quality Assurance Management Staff be responsible for providing technical guidelines to ensure that adequate planning and implementation of QA/QC occurs in all EPA-funded programs that involve environmental measurements. In support of this responsibility, data quality objectives (DQOs) are developed as the initial step in the process leading to the preparation of the QA project plan. The QA project plan specifies the policies, organization, objectives, and QA/QC activities needed to achieve the DQOs.

DATA QUALITY OBJECTIVES

The application of DQOs increases the likelihood of collecting data that will meet the needs of data users as well as providing for greater efficiency and success in data collection activities. The EPA Quality Assurance Management Staff has defined guidelines and specifications for developing DQOs. The inherent quality of a data set is represented in terms of five characteristics: precision, accuracy, representativeness, completeness, and comparability. Brief explanations of these characteristics follow:

* Precision and Accuracy - quantitative measures that characterize the variability and bias inherent in a given data set. Precision is defined by the level of agreement among multiple measurements of the same characteristic. Accuracy is defined by the difference between an estimate based on the data and the true value of the parameter being estimated.

* Representativeness - the degree to which the data collected accurately reflect the population, group, or medium being sampled.

* Completeness - the quantity of data that is successfully collected with respect to that amount intended in the experimental design. A certain percentage of the intended data must be successfully collected for valid conclusions to be made. Completeness of data collection is important because missing data may reduce the precision of estimates or may introduce bias, thereby lowering the level of confidence in the conclusions drawn from the data.

* Comparability - the similarity of data from different sources included in a single data set. Because more than one sampling crew was collecting samples and more than one laboratory was preparing and analyzing the samples, uniform procedures must be used. This ensures that samples are collected in a consistent manner and that data from different laboratories are based on measurements of the same parameter.

Sampling Objectives

DQO concepts that had been developed for analytical laboratory operations were difficult to apply to soil sampling activities. DQOs for soil sampling were developed to ensure that field operations, e.g., sampling site location, profile description, and sampling, would be conducted in a consistent manner. These objectives were intended to reduce the error inherent in collecting soils data and to provide an indication of the variability among sampling crews.

The DQOs presented in this section were developed by the ERL-C DDRP staff. That development included the preparation of a detailed DQO document which was used to guide sampling activities in the Northeastern region. Subsequently, the DQOs were revised to reflect modifications for the SBRP soil survey. The following paragraphs also contain information from the QA project plan (Bartz et al., 1987).

Precision and Accuracy--

The regional correlator/coordinator (RCC) must be a soil scientist with several years experience in soil profile description and soil mapping. The RCC monitors one site per sampling crew for adherence to SCS standards, procedures, and sampling protocol modifications, and performs an independent duplicate profile description. At least one site in each state is monitored with the SCS state staff representative while the remaining sites may be monitored independently. Monitoring includes preparing a duplicate profile description and reviewing selection of sites for sampling. The RCC also insures that SCS state staffs perform duplicate profile descriptions. During this process, the RCC identifies, discusses, and resolves any significant issues. Written reports are submitted to the sampling task leader at ERL-C within two weeks. The resolution of major issues is reported verbally within two working days.

A representative of the SCS state staff independently describes a minimum of one site per sampling crew. These independent pedon descriptions are used to assess the variability in site descriptions among soil scientists. The SCS representative monitors adherence to protocol for site selection, labeling, and sampling. The soil profile is described on the same face of the pit described by the sampling crews. The representative makes the assessment while the crew is describing and sampling the pedons. Written reviews are submitted to the sampling task leader at ERL-C within two weeks. Major discrepancies are reported verbally within two working days.

The QA representative audits each sampling crew at least once to ensure adherence to sampling protocol. Written reports are submitted within two weeks. Major discrepancies are reported verbally within two working days.

A small percentage of the sampling classes are selected randomly by EPA for replicate sampling to determine the within-class variability. These replicate pedons, called paired pedons, are selected before sampling begins. The paired pedon and the routine pedon from a representative site for each selected sampling class are sampled on the same day by the same field crew. The criteria for the paired pedon are the following:

- Establish sufficient distance between the two sampling locations to avoid disturbing the paired pedon because of the sampling of the routine pedon.
- Use the same sampling class and vegetation class as for the routine pedon.
- Use the same slope position as for the routine pedon.

Sample pits are located accurately on the soil survey maps, and the pit dimensions and the long azimuth are recorded. The pit face from which samples are removed is recorded, and the location of the pit in the field is flagged or identified so that the site can be revisited. The soil profile is described according to SCS protocols.

One horizon per day is sampled in duplicate by each field crew. The choice of horizon is made at the discretion of the field crew, although an attempt is made to sample across the range of horizon types. The sample is taken by placing alternate trowelsful of sample into each of two sample bags. One field duplicate is included in each set of samples sent to a preparation laboratory.

Representativeness--

The primary concerns in the selection of sampling sites are (1) to assess soil characteristics, (2) to integrate information on parent material, internal drainage, soil depth, slope, and vegetative cover, and (3) to determine representative sampling classes. Soils which have been identified in the study regions have been combined into groups, or sampling classes, which are either known to have or are expected to have similar chemical and physical characteristics. Each of the sampling classes can be sampled across a number of watersheds in which they occur. In this approach, a given soil sample does not represent the specific watershed from which it came, rather, it contributes to a set of samples which collectively represents a specific sampling class on all watersheds within the sampling region. The lead soil scientist of the sampling party selects a sampling site representing the designated sampling class and vegetation class within the designated watershed. Five random points are assigned at each site. Sampling crews must proceed to the first designated point and must determine if the sampling class and vegetative cover specifications are satisfied. If the point is unsatisfactory, the crew proceeds to the next point and so on until a satisfactory sampling site representative of the sampling class and vegetation class is found.

Completeness--

Soil sampling protocols specify the sampling of 100 percent of the designated pedons and of the prerequisite number of horizons. If samples are lost, spilled, or mislabeled, it is possible to return to the field and resample the same site. If a sampling site is inaccessible, the reason for excluding the site must be formally documented by the sampling crew.

Comparability--

The consistent use of SCS methods, personnel, and data forms for the sampling phase provides field and analytical data that are qualitatively comparable to data generated from SCS investigations and other studies which have utilized a similar approach. The data are quantitatively comparable only to soil surveys utilizing a randomized site selection procedure.

Fulfillment of Objectives

Precision and accuracy--

Eleven paired pedons (10 percent of the total number of routine pedons sampled) were sampled to provide information on variability between morphologically matched pedons. Additional precision and accuracy estimates will be discussed in the forthcoming QA report on the analytical data (Palmer et al., in preparation)

Representativeness--

All pedons sampled were within the range of morphological characteristics as assigned for their respective sampling classes. Data analysis activities should assess whether or not the sampling classes, as defined by the physical, chemical, and mineralogical data, are separate populations. The results will be discussed in the forthcoming QA report on the analytical data.

Completeness--

A total of 110 routine pedons were sampled of the 114 pedons initially selected, resulting in 96 percent completeness. In addition, two pedons were added to the list, and two pedons were not sampled (see Table 2). Although this does not meet the 100 percent goal, the number of samples collected should provide sufficient data for valid conclusions to be made for all sampling classes.

The number of field duplicates obtained during routine and special interest watershed sampling satisfied the DQO goal, which specified that each sampling crew was to collect one horizon in duplicate on each day of sampling.

Comparability--

The comparability of morphological characteristics is discussed in detail under the heading "Review of Profile Descriptions". The comparability of physical, chemical, and mineralogical data obtained from different analytical laboratories using several reporting standards and different analytical methods will be addressed in the forthcoming QA report on the analytical data.

EVALUATIONS AND AUDITS

The objective of on-site observations is to assess the quality of sampling activities performed by the sampling crews. Three categories of observations were conducted for the sampling activities by the SCS state staffs, RCC, and the QA auditor. The activities observed, DQO levels of effort, deviations from protocol, and difficulties encountered are discussed below.

Evaluations by the Soil Conservation Service State Staff

SCS state staffs were responsible for evaluating the sampling crews in their respective states as a quality control measure. It was desirable for these evaluations to be conducted by SCS staff who were not members of the sampling crews to ensure that evaluations would be as objective as possible. Written reports documented that all crews were evaluated at least once during the survey.

No difficulties were documented in the written reports. Site selection and sampling protocols were not discussed in the reports for all crews. Most reports were brief with little detail concerning the areas covered during the evaluation. The report for the observation of the GA01 and GA02 sampling crews stated that additional staff were added to the crew to allow soil sampling activities to be completed in a timely manner.

Evaluations by the Regional Correlator/Coordinator

EPA contracted a former SCS soil scientist to serve as RCC. All sampling crews were audited, including VA01 which sampled five special interest pedons in Virginia.

Sampling site location, sample labeling, and sampling protocols were evaluated during the RCC review, although the written report concerning these areas is brief. The written reports identified no major deviations from the protocols. However, detailed discussions of questions concerning protocols and the RCC's suggestions were not provided. Names of sampling crew members and SCS state staff also reviewing the site were included in the written report.

Audits by Quality Assurance Staff

ERL-C QA staff performed complete audits for six of the nine SBRP sampling crews. For NC01, the auditor observed the site selection, pit excavation, and profile description. Sample collection activities were not audited. For GA02, the protocols were reviewed with the sampling crew members, but an audit was not conducted because field activities were postponed because of rain. The sampling of special interest watersheds by VA01 was not audited.

A written report and a checklist of activities observed were completed for each audit conducted. The auditor corrected any protocol deviations observed at the time of the audit and documented issues of concern in the written audit report. A summary report evaluated sampling crew performance for all sampling crews audited.

Concerns identified during the audits included the following:

- In the protocols, it was unclear if clod samples were to be collected for both routine and field duplicate horizons. This issue was resolved after discussion with the soil sampling task leader. It was decided no additional clods would be required for the field duplicate horizon.
- Field data forms were not filled out at the time of soil description and sampling by GA01.
- GA01 did not label samples in the field.
- Several sampling crews did not fill out field log books in the field, but completed them later.
- GA01 and GA02 did not have enough crew members to perform all required tasks. The auditor believed that a minimum of four sampling crew members was required to perform all assigned tasks.
- GA01 used the SCS blue-sheet soil series descriptions to determine horizon designations. (Note: Blue sheets represent the typical series description with a range of characteristics.) This practice is not appropriate for DDRP characterization where the objective of soil description is to characterize the pedon that is sampled.

The QA auditor observed the following favorable practices:

- Two holes punched in a photogray card with a flag rod run through them were found to work well to anchor the card in place during the photographic documentation of each pedon.
- Some crews left the photogray cards at the sampling sites to provide an explanation for the excavation. Local authorities had received occasional reports of graves being dug in odd locations.
- Some sampling crews decided that spraying clod samples with water before dipping might inhibit the absorption of the saran, instead of enhancing the process as expected. Sampling crews were given permission to discontinue spraying clods with water before dipping.

REVIEW OF LOG BOOKS

Sampling Log Books

Sampling log books maintained by all sampling crews were reviewed for completeness in terms of the following information:

- On-site observations by the RCC, SCS state staff, and QA staff, including documentation of concerns discussed with the evaluator or auditor.

- Difficulties encountered in locating any sampling site.
- Site conditions or soil characteristics that could have an effect on the analytical results.
- Sampling procedures that might affect the quality of the samples collected.
- Difficulties with equipment or supplies.
- Comments regarding adherence to protocol, including any procedural modifications or recommendations for future surveys.

An examination of sampling log books indicated a wide range in the amount of detail recorded, which can be attributed partially to the lack of a specified format for log book entries. Several sampling log books contained no record of sampling crew members. The lack of a master list of exposures taken by each crew made it difficult to evaluate the completeness of the photographic record for SBRP field activities.

Sample Receipt Log Books

Sample receipt log books from the preparation laboratories were reviewed for completeness in providing the following information:

- Condition of samples upon arrival at the preparation laboratory.
- Labeling errors and correction of mislabeled samples.
- Sampling difficulties or protocol deviations identified in sampling log books and documented upon receipt of the sample at the preparation laboratory.
- Sampling level of field duplicates for comparison with DQO goals.

The sample receipt log books did not provide all information expected. However, the preparation laboratory may maintain other notebooks containing this information that were not reviewed for this report. The log book from one laboratory was compiled after the interagency agreement was in place, therefore, this log book does not provide sample condition upon receipt because the samples had been delivered by the sampling crews approximately one month before this log book was compiled. The other log book followed a column and row format. Column headers were the following: date, time, who delivered or crew ID, who received sample, condition as placed in storage, sample ID, clod ID, number of clods per horizon, clod condition, and remarks. The left page contained information on the bulk samples and the right page, on the clod samples. The cooler temperature was recorded for each group of samples delivered. Generally, sampling crews logged in samples as the samples were delivered to the cold storage facility. Occasionally, the farm manager or preparation laboratory personnel assisted. Most deliveries were made after 5:30 PM, and several deliveries were made on Saturday and Sunday. According to the documentation, all samples arrived in good condition.

Although most entries were made in black ink as required by protocol, entries for 148 samples collected during April and May 1986 were made in pencil. Entries for six samples were recorded in blue ink. Pencil and blue ink do not photocopy well, and pencil entries tend to wear and become illegible. The QA auditor reiterated the need to use black ink pens.

Corrections to sample codes which were requested by the sampling task leader and EMSL-LV staff were made by crossing out part of the original sample code and clearly writing the correction above the original entry. The changes were not initialed; however, the original entries did remain legible as required by protocol.

REVIEW OF PROFILE DESCRIPTIONS

Paired Pedon Descriptions

Eleven paired pedons were sampled to provide information on variability between morphologically matched pedons. Both the routine and replicate pedons of each pair are described and sampled according to the protocols used for all routine sampling.

The objective of paired pedon description and sampling is to gain some indication of the spatial variability of field-observed characteristics and physical and chemical soil properties over short distances. The determination of physical and chemical parameters will yield quantitative data that may be used in statistical comparisons during data analysis.

The qualitative components of the paired pedon descriptions were evaluated for this report. Differences in horizon designations and other descriptive parameters, e.g., field pH, color, roots, and rock fragments, constitute the basis for comparison. Analysis of profile descriptions for paired pedons may give a different picture of similarity than analysis based on the results of physical and chemical data. Any qualitative differences determined in the comparison of paired pedon descriptions are not intended to be used for any specific purpose other than documenting the variability observed during the SBRP soil survey.

The qualitative classification of the paired pedons is summarized in Table 3. The pedon descriptions were systematically reviewed by comparing the field observations of descriptive parameters between the routine and replicate pedons. Ranges of characteristics for descriptive parameters were defined to make the comparison. Subsequently, the paired pedons were classified as similar, moderately different, or very different based primarily on soil morphology. Of the 11 paired pedons evaluated, 55 percent of the pairs were judged to be similar, 36 percent were moderately different, and 9 percent were very different. Both pedons of each pair were located within the same sampling class and the same vegetation class.

Paired pedons may be compared with respect to both the correlation of the horizon designations and the correlation of field-measured characteristics of horizons identified for both pedons. When there is little agreement in the horizon designations for the routine and paired pedons, quantitative comparisons of field-measured characteristics are not possible.

A qualitative comparison of the characteristics for pedons classified as very similar revealed that no additional information on variables within pedon pairs was gained beyond that derived by determining the proportion of horizon designations in common for those pairs. Even when the paired descriptions were similar, the field-measured properties, e.g., horizon thickness, were found to differ considerably.

Pedon pairs that were classified as moderately different were those that differed from each other in 22 to 71 percent of the total number of horizon designations. Although 71 percent of its horizons were described differently, one pedon description was classified as moderately different because of comparability between other characteristics.

TABLE 3. SUMMARY OF THE QUALITATIVE DIFFERENCES BETWEEN PAIRED PEDONS

Watershed ID	Sampling Class	Crew ID	Pedon Comparison	Total Horizons	Horizons Described Differently	
					Number	Percent
			Georgia			
2A0-8805	FL	GA02	S[b]	8	0	0
2A08904	ACC	GA01	M[c]	9	5	56
2A0-8910	OTL	GA01	S	7(6)[e]	1	14
			North Carolina			
2A0-7826	ACL	NC01	M	7	2	29
2A0-7830	ACH	NC01	D[d]	7(5)	5	71
2A0-7833	FR	NC03	S	8(7)	1	13
2A0-7834[a]	SHL	NC03	S	4	0	0
2A0-7823	SKX	NC03	S	4	0	0
2A0-7829	MSL	NC04	M	9(8)	2	22
			Tennessee			
2A0-7802	SKV	TN02	M	7	5	71
2A0-7805	MSH	TN01	S	7(8)	1	13

[a] This paired pedon was originally to have been sampled on watershed 2A0-7830.

[b] Similar (S).

[c] Moderately different (M).

[d] Very different (D).

[e] The number of horizons described for the routine pedon are given first, followed by the number of horizons described for the paired pedon in parentheses.

The pedons classified as very different were those that exhibited differences in horizon designations exceeding 71 percent. Generally, the characteristics of the surface horizons of these pedons were more similar than were the subsurface horizons. At lower depths in the pedons, differences in horizon designations become relatively greater and characteristics of the horizons are more variable differed.

Comparison of paired pedons at the qualitative level appears to be a useful exercise only for describing the inherent variability of the sampling classes. The value of this comparison for future surveys can be determined only after the analytical data have been analyzed statistically. The low correlation between the routine and replicate pedon suggests some difficulty in sampling qualitatively similar pedons utilizing the sampling design employed in this survey. The lack of qualitative similarity between paired pedons does not necessarily mean these soils are dissimilar for the purposes of DDRP, because similar soils are defined by sampling classes.

The results of the laboratory analyses for paired pedon samples should be analyzed and reviewed before a final determination of the variability between paired pedons and within sampling classes is assessed. The conclusion that only 55 percent of the paired pedons are similar should be considered when examining the laboratory data. It may be difficult to evaluate the variability of the paired pedons and the sampling classes based on the analytical results only.

In summary, this examination of the field-described characteristics demonstrates the difficulty encountered in matching soil profiles and characteristics over a distance of a few meters for pedons of the same soil series. Linking data for all pedons within a sampling class over the entire region is expected to be even more difficult.

Independent Pedon Descriptions

The RCC and SCS state staff evaluations often included the preparation of independent pedon descriptions. These were compared with the sampling crews' pedon descriptions. For two pedons, independent descriptions of the same pedon were made by the sampling crew, the RCC, and the SCS state staff. A total of 13 independent descriptions were made either by the sampling crew and the RCC or by the sampling crew and the SCS state staff.

The purpose of performing independent pedon descriptions is to provide a basis for qualitatively evaluating the variability that occurs when two or more soil scientists describe the same pedon. Although the standards and guidelines routinely used by SCS often are based on precisely defined terms, the consistency in application is not always perfect. A certain degree of subjectivity is inherent in this process, which allows some variability between individuals in making observations of the same pedon. For example, the color of one horizon may be described in three different ways by as many describers. The precision of comparing a soil sample with a Munsell color chip is primarily influenced by the amount of sunlight present, the moisture content of the sample, and the ability of the describer to distinguish hue, value, and chroma differences.

Independent pedon descriptions are useful for comparing subjective field characteristics, such as horizon boundaries, soil texture, or color. Usually, horizon designations are determined by evaluating a range of physical characteristics and interpreting their relationship to soil development. Independent pedon descriptions are comparable only when the participants describe the same face or portion of the pedon.

Independent pedon descriptions are summarized in Table 4. The horizon designations for each pedon description were evaluated with respect to all field-measured variables recorded on the field data forms, according to the same procedure used for paired pedon descriptions. Soil colors were the most often noted differences between the descriptions. These may be related to variability in the describers' vision or actual color variability in the samples. Soil pH differences may have been due to differences between soil samples or the types of pH reagent used, as well as differences in perception of the pH color charts. Generally, there was insufficient information provided on the field data forms to determine if the descriptions were made in the same location or on the same face of the soil pit.

TABLE 4. SUMMARY OF INDEPENDENT PEDON DESCRIPTIONS EVALUATED

		Describers			Horizons Described		
			Evaluator			Differently	
Watershed ID	Sampling Class	Crew ID	RCC	SCS	Total	number	percent
2A0-7806	ACH	TN02	x	x	-	-	-
2A0-7811	SKV	TN01	-	x	8	0	0
2A0-7813	---	NC04	x	-	8(9)[a]	1	11
2A0-7817	SKX	TN01	x	-	5(6)	2	33[bcdef]
2A0-7826	ACC	NC01	-	x	11	0	0[g]
2A0-7829	MSL	NC04	-	x	9	0	0
2A0-7830	ACH	NC01	x	-	5	2	40[c]
2A0-7833	FR	NC03	-	x	8(9)	4	44[chi]
2A0-7882	ACH	NC02	x	x	-	-	-
2A0-8801	MSL	GA02	x	-	12(9)	6	50[j]
2A0-8803	FL	GA02	-	x	8	0	0[bhk]
2A0-8810	ACC	GA01	-	x	7	0	0[hi]
2A0-8904	FL	GA01	x	-	6	0	0[bhikl]
2B04-7916	MSL	VA01	x	x	8	3	38[klm]
Coweeta #36	ACH	NC03	x	-	6	3	50[l]

[a] The number of horizons described for the first description are given first, followed by the number of horizons described for the second description in parentheses. Intercomparisons were not possible when triplicate descriptions were made.

[b] Texture

[c] Structure

[d] Depth

[e] Horizon thickness

[f] Based on the descriptions provided, it appears that different faces of the soil pit were described.

[g] Field-observed pH

[h] Soil color

[i] Roots

[j] Incomplete field data form received for evaluation.

[k] Horizon boundary

[l] Rock fragments

[m] Sampling class

Unless it is certain that descriptions are made within a specific, delineated area of the exposed soil profile, independent pedon description comparisons can be only qualitative. It was not possible to conduct a more detailed comparison of the field descriptions because only one pedon (watershed ID 2A0-7806) was known to have been described by all three describers for a specific portion of the pedon.

DATA ENTRY AND MANAGEMENT

This section describes the software, procedures, and QA/QC measures used during the development of the computerized data base. Data entry protocols included visual scanning of the data forms, computer entry, entry checking, and editing. The specific software, procedures, and checks varied according to data type and also evolved through time because of adjustments in the data collection protocols, reporting forms, available computer software and equipment, and personnel.

Soil Mapping Data Files

In the Fall of 1985 and Spring of 1986, SCS soil scientists mapped 35 watersheds in SBRP. Transects were made on the mapped watersheds to determine mapping unit composition. SCS state staffs prepared watershed attribute maps that delineated soil types, vegetation cover types, bedrock geology, depth to bedrock, and land use at a scale of 1 : 24,000. Bedrock geology delineations were derived from existing geological maps. The other maps were derived from data collected as part of DDRP.

Preliminary map legends and mapping unit descriptions were prepared by SCS state staffs using existing soil surveys, topographic maps, and aerial photography. After mapping was completed, the provisional legends and mapping unit descriptions were correlated at a workshop held in Corvallis, Oregon in March 1986. Using data from field transects, the workshop participants applied a consistent mapping unit nomenclature and composition from state to state. Most of the mapping units were described as consociations or complexes of soil series, although a few mapping units were defined as consociations or complexes at a higher taxonomic category, e.g., Great Group.

Each mapping unit description form included the mapping unit name, slope, landscape position, landform, parent material, depth to bedrock, taxonomic classification, and inclusions of unnamed soils occurring in the mapping unit. The map legends and mapping unit description forms were scanned for legibility, completeness, and accuracy. Any discrepancies were resolved through communication with the SCS state staffs.

Following the workshop, both ERL-C and ORNL entered the watershed map attribute data, soil transect data, and mapping unit description data into their respective computer systems. Data entry at ORNL was performed by an in-house data entry center and the resulting files were transferred to SAS files (SAS Institute Inc., 1987) on the IBM 3033 system. ERL-C entered the data using dBase III software on an IBM personal computer. The ERL-C files were transferred to ORNL in an ASCII format and were uploaded to SAS files on the IBM 3033 system. Next, the two files were compared for discrepancies.

Discrepancies in watershed attributes were resolved through legend corrections and some remapping by the SCS state staffs, and the revised data were entered into the data base. ERL-C used the Arc/Info geographic information system (GIS) to digitize the watershed attribute files. Then ERL-C compared the updated watershed attribute data with the digitized watershed attribute data, and resolved any inconsistencies. Finally, the GIS-derived mapping unit areas were adopted as the most reliable.

The mapping unit data are maintained in three files: mapping unit legend file, mapping unit composition file, and mapping unit component file. The legend file contains data pertaining to the identification of the mapping unit, including the symbol, name, and physiographic information. The composition file contains the percentage of individual components found in each mapping unit. The component file contains data on each named soil or inclusion, such as slope, drainage class, and taxonomic classification. The reasons for splitting the data into three files were to reduce the amount of redundant information stored in a single file and to facilitate the review and comparison of the mapping unit components.

ERL-C sent listings of the computerized mapping unit files to the SCS state staffs for review and resolution of apparent inconsistencies. Several iterations of updates were entered into the SAS files at ORNL. The corrections were entered into a change file which contained the record identifier, the variable name, the old value, and the new value. Then the change file was compared with each record in the data base. Only when all three items matched an observation in the data base was the new value inserted. This method of updating the data base virtually eliminated the possibility of adjusting the wrong observation or variable.

After the updates were made, ORNL generated frequency tables of the coded variables and compared these tables with lists of valid codes. The frequency tables were used to build code translation tables containing the codes and their definitions. The code translation tables are stored as SAS format libraries in the data base.

The final step in editing the mapping data files involved the labeling of variables and, where necessary, the modification of variable names and labels to ensure consistency among the data files. The complete contents of the mapping files are described in Turner et al. (1987).

Soil Sampling Data Files

Each sampling location and soil profile were described in conjunction with soil sampling. During the training workshop at the University of Tennessee-Knoxville, the sampling crews were instructed in uniform procedures for describing the soils and recording data on the field data forms.

Upon completion of sampling in the Spring of 1986, copies of the data forms were sent to ORNL, ERL-C, and EMSL-LV. At ORNL, the forms were scanned visually for completeness, legibility, and the validity of code entries. ORNL personnel noted any missing, illegible, or suspect data.

To computerize the data, ORNL created a custom dBase III data entry program. SCS state staff entered the field data using this software and sent diskettes to ORNL. The handwritten field data forms also were forwarded to ORNL for data entry by using the dBase III software program. The two files were uploaded to SAS data files on the IBM 3033 computer system and were compared using SAS procedures. A list of discrepancies was generated. This list was compared with the original field data forms, and a change file was generated using the record identifier, the variable name, the incorrect observation and the correct observation. Corrections were made to the data using the same procedure as that described for the mapping unit files.

The data were entered as two linked files. The base file, designated 232 BA, contains one record for each pedon. Data pertinent to the entire pedon, such as identifier, date sampled, location, taxonomic classification, and physiographic information, are stored in this file. These data were reported on the first page of the field data form. The horizon file, designated 232 HO, contains the horizon characteristics, such as horizon depth, thickness, color, and structure. These data were reported on pages 2 through 4 of the field data form.

The EMSL-LV staff developed and implemented procedures to evaluate the data recorded on the field data forms (Bartz et al., 1987). Following receipt of the field data forms, QA staff examined the forms for suspect data and sent a list of discrepancies to the SCS state offices for resolution. SCS returned the confirmed or corrected data. These data were entered into a change file, and were integrated into the data base.

ORNL generated frequency tables of coded variables and compared them to a list of valid codes. Invalid or suspect codes identified by this procedure were sent to EMSL-LV for resolution. This resulted in another round of updates which were incorporated into the data base.

As with the mapping data, labels were assigned to all field variables and, where necessary, variable names and labels were modified to ensure consistency among the various data files. The complete contents of the field data files are discussed in Turner et al. (1987).

SECTION 4

RECOMMENDATIONS AND CONCLUSIONS

Recommendations for resolving issues and concerns stemming from the SBRP soil survey operations are summarized in this section to aid in the design of future surveys. Although the detailed discussions provided in the text of this report are not reproduced in this section, recommendations are presented in their order of occurrence in the text. A summary assessing the overall quality of the soil sampling operations concludes this report.

RECOMMENDATIONS

Site Selection

A letter on EPA letterhead should be provided to sampling crews for use in assuring private landowners that the sampling crew represents EPA in collecting data of local and regional significance.

The criteria provided below for selecting pedons for sampling in which the desired sampling class occurs only as an inclusion in the mapping unit should be incorporated into any protocol revision:

- The mapping unit must contain inclusions that fit the required sampling class.
- The sampling class must make up at least 20 percent of the mapping unit.
- A pedon meeting the constraints of the sampling class can be located.

A method for assessing the vegetation composition at the sampling site and for determining if it satisfies the vegetation class requirements should be incorporated into revised protocols. Consideration should be given to defining the size of the area in relationship to the sampling point and to establishing a procedure for evaluating stand composition, particularly for the mixed class designation.

Supplies and Equipment

Preparation laboratory personnel should ensure that all equipment is serviceable in advance of distribution to the sampling crews. Crews should inspect all equipment before it is taken into the field.

Supplies should be distributed evenly among sampling crews to ensure that each crew has a sufficient supply for two weeks of sampling work.

Operating and repair instructions should accompany equipment such as cameras and hand pumps. If operating instructions are not available, training should be provided at the workshop.

Sampling crews should be provided with 35-mm cameras for photographic documentation of pedon characteristics. Personal cameras also may be used.

ASA-200 film is recommended for general use. However, ASA-400 film is recommended for taking photographs under shady conditions without using a flash attachment.

Photogray cards with dimensions of 8.5 by 11 inches are recommended for better visibility in the slides.

Two holes punched in a photogray card with a flag rod run through them were found to work well to anchor the card in place during the photographic documentation of each pedon.

Some sampling crews recommended leaving the photogray card on-site to provide an explanation for the excavation, because local authorities had received occasional reports of graves being dug in odd locations.

White golf tees are recommended for marking soil horizon boundaries.

Khaki cloth measuring tapes with white interval markings are recommended to provide better visibility in the slides.

Marking pens supplied to sampling crews should be indelible on all surfaces.

Standardized pH kits with fresh reagent should be supplied to all sampling crews to ensure that comparable results are produced.

Preparation laboratories should mix the saran-acetone solutions for the sampling crews. Sampling crews should give at least two days advance notice of their need for the solution.

Hole punches, garden clippers, and digging bars are recommended as routine sampling equipment.

Hand pumps should be equipped with discharge hoses that are of sufficient length to extend from a soil pit that is 2 meters deep.

Clod Sampling

One standard saran:acetone solution should be used. Because acetone is volatile, the sampling crew will have to carry a separate container of acetone for maintaining the solution at a nearly constant viscosity. Clods should be immersed in the saran-acetone solution only once and for a set period of time. If a clod is dipped more than once, this information must be recorded on the clod label and in the sampling log book. Safety precautions must be taken because acetone is flammable, and both saran and acetone are carcinogens.

Some sampling crews suggested that spraying clod samples with water before dipping might inhibit the absorption of saran. They recommended that the practice be discontinued.

Sample Labeling

Samples should be labeled by the field crews while they are in the field.

Labels should be checked against (1) a master listing of the pedon codes identifying the sampling sites and (2) copies of the field data forms accompanying the samples to be delivered.

Preparation Laboratory Support

Preparation laboratories should be operational before soil sampling begins. This will ensure that the preparation laboratories can provide logistical support for the sampling operations.

Sample tracking procedures should be detailed in the EPA Statement of Work and should be included in the protocols for future surveys. Specifically, these protocols should emphasize that (1) the person delivering samples to the preparation laboratory is responsible for documenting which samples have been delivered and (2) the preparation laboratory personnel are responsible for verifying that a sample exists at the laboratory for each log book entry. This redundancy in recording and checking sample codes is necessary for the QA documentation of the transfer of sample custody from the sampling crew to the preparation laboratory.

The preparation laboratory should be provided with (1) a master listing of the pedon codes identifying the sites designated for sampling and (2) copies of the field data forms accompanying the samples delivered. The laboratory manager should make arrangements to have a copying machine available when samples are delivered.

Each sampling crew should arrange a mutually satisfactory delivery schedule with the preparation laboratory manager. Because the area used for sample storage is required to be secure, i.e., locked, advance arrangements should be made for access. Phone numbers of the appropriate laboratory personnel should be provided to the crews.

Field Data Forms and Codes

The training workshop should put more emphasis on the proper entry of data onto the field data form. The protocols should provide detailed instructions for completing the field data form.

The protocols should stress that original field data forms should be completed in the field by using permanent ink or an indelible marker. Preliminary data forms that are later copied without change onto final data forms are acceptable. However, both versions of the form must be submitted to the QA staff for data verification.

Suggested modifications to the field data form include the following:

- The brown shading on the back page should be eliminated or lightened because it interferes with photocopy reproduction of the forms and the legibility of the photocopies.
- The column for horizon depth, upper and lower, should be identical to the header column.
- An upper and lower division of the boundary column is not needed.
- The organization of the code legend on the form could be better. The codes are difficult to find because they are not presented in the order in which they are used in filling out the form.

Additional codes should be provided, as indicated in the following categories:

- Geomorphic Position
    - Floodplain
    - Footslope (colluvial deposit)
    - Toeslope (colluvial deposit)

- Local Landform
    - Cove

- Land-Use
    - Abandoned land
    - Abandoned pasture
    - Idle land

- Parent Material Origin
    - Metasedimentary (MS)
    - Mixed materials
    - Crystalline materials
    - Schist
    - Phyllite

    (Note: Separate sampling classes were distinguished by schist and phyllite; however, only one code, M5, was provided.)

- Field-Measured Property (Kind)
    - Old root channels
    - Worm casts
    - Krotovinas, i.e., a former animal burrow that has been filled with organic matter or material from another horizon.

The following changes are recommended for use on a field data form modified specifically for future DDRP soil surveys :

- Pedon Code (replaces Sample Number): An 8-digit code made up of state, county, and unit designations, e.g., NC113-02.

- Watershed ID: An 8-digit code to identify a watershed. Leading zeros could be added to standardize the 6- and 7-digit codes, e.g., 1A3007 and 2A07907, which were used in the Northeastern and SBRP regions, respectively.

- Class ID: A 3-digit code to identify a soil sampling class; e.g., S09 in the Northeastern soil survey or OTC in the SBRP soil survey.

- Site Number: A 1-digit number from 1 to 5 to indicate the random point used for sample site location.

- Transect Azimuth: A 2-digit code to designate the ordinal direction of the transect line from the random number point, e.g., 0N, NE, NW. A "00" should be used if the random point was sampled.

- Transect Distance: A 3-digit code from 001 to 150 to specify the distance in meters in the transect azimuth direction from the random point to the sampling point.
- Sample Type: A 3-digit code to designate the type of sample and number of bags of sample obtained, e.g., R12 or FD1.
- Horizon Number: A 2-digit code to indicate the number of the horizon on the field data form.

From the above codes, two new identification codes can be constructed:

- Location Code: A 17-digit code combining the Watershed ID, Class ID, Site Number, Transect Azimuth, and Transect Distance.
- Sample Code: A 13-digit code combining the Sample Type, Pedon Code, and Horizon Number. This would be recorded on the sample bags.

Recommendations to modify the interactive software program to enter the field data include:

- Developing instructions to enter data for horizons that were split because of thickness.
- Developing instructions to enter independent pedon description data. A specific entry field, e.g., a sub-unit field of "Sampler", should be provided on the form to identify the describer as sampling crew, SCS state staff, or RCC.
- Developing an entry system to allow entry of data from a modified field data form.

Soil Conservation Service State Staff Evaluations

It is recommended that the SCS state staffs be provided with a detailed questionnaire to ensure that all sampling site selection and soil characterization activities are evaluated and that detailed written documentation is produced. Standard questionnaires are particularly important for these evaluations which, unlike the RCC evaluations, are performed by different individuals. It is important that all sampling crews, within and among states, be evaluated according to uniform criteria to assure the comparability of the evaluations.

Comparability would be enhanced if all staff performing on-site observations participated in a training session. QA staff should make arrangements for a training session of this nature.

The SCS state staff evaluations are most useful when performed as early in the survey as possible. The procedural variations among sampling crews should be assessed and included in the written report. Difficulties and concerns should be discussed and any recommendations for corrective action should be provided. In addition, when corrective action is necessary for a given crew, a subsequent evaluation should be made to verify that the corrective action was implemented.

All crews should be evaluated at least once and as early as possible in the soil sampling activities.

Regional Correlator/Coordinator Evaluations

It is recommended that the RCC be provided with a detailed questionnaire to ensure that all sampling site location and soil characterization activities are evaluated according to uniform criteria and that detailed written documentation is produced. The evaluations should be performed as early in the survey as possible. This would allow the RCC an opportunity to clarify the protocols with each crew. The clarifications should be written, and after the approval of the sampling task leader and the QA staff, the information should be provided to all crews early enough in the survey to benefit the sampling effort.

Difficulties and concerns should be discussed and any recommendations for corrective action should be provided. When corrective action is necessary for a given crew, a subsequent evaluation should be made to verify that the corrective action was implemented.

The RCC should assess the procedural variations among sampling crews and should include the assessment in the final written report.

The QA staff should conduct a workshop to train the RCC and SCS participants in the requirements of on-site evaluations and the content of the written reports.

The RCC should evaluate all sampling crews at least once and as early as possible in the soil sampling activities.

Quality Assurance Staff Audits

Audits should be performed as early in the survey as possible in order to identify initial difficulties and allow for written corrections and clarifications of the protocols to be made early enough in the survey to be of benefit to the sampling effort. When corrective action is necessary, the activities of the sampling crew should be audited again to ensure that protocols are being followed as specified. Comprehensive documentation of the audits and any corrective actions will assure that a complete assessment of sampling operations is available at the end of the survey.

Scheduling of audits should be flexible enough to ensure that sampling crews are observed conducting all activities associated with soil sampling. In particular, it is recommended that special attention be given to compliance with the stated protocols for sample labeling and completing field data forms. For QA purposes, it is critical to observe each crew performing all activities and to document the observations. Protocol deviations observed during the sampling activities should be discussed with the sampling crew after the day's activities have been completed.

Sampling Log Books

It is recommended that several forms be developed as a basis for detailed documentation of daily sampling activities, and be distributed as a hardbound sampling log book for future surveys. Suggested forms are provided in Figures 3 through 7.

- A format for identifying sampling crew personnel is provided in Figure 3.
- A format for summarizing the contents of the sampling log books is provided in Figure 4.
- Suggested formats for site location and soil sampling information are provided in Figures 5 and 6, respectively.
- A master list of the exposures taken would be useful. A slide key such as that outlined in Figure 7 could provide an easy reference for sampling crews to use in labeling processed

Field Crew Members: ______________________________ Field Crew: ____________

____ ____________

____ ____________

Field Crew Leader: ____

____

____

Routine Staff: ____

____

____

____

____

Additional
Participants: ____

____

____

____

____

____

____

Notes: ____

____

____

____

____

____

Audit Visits: ____

____

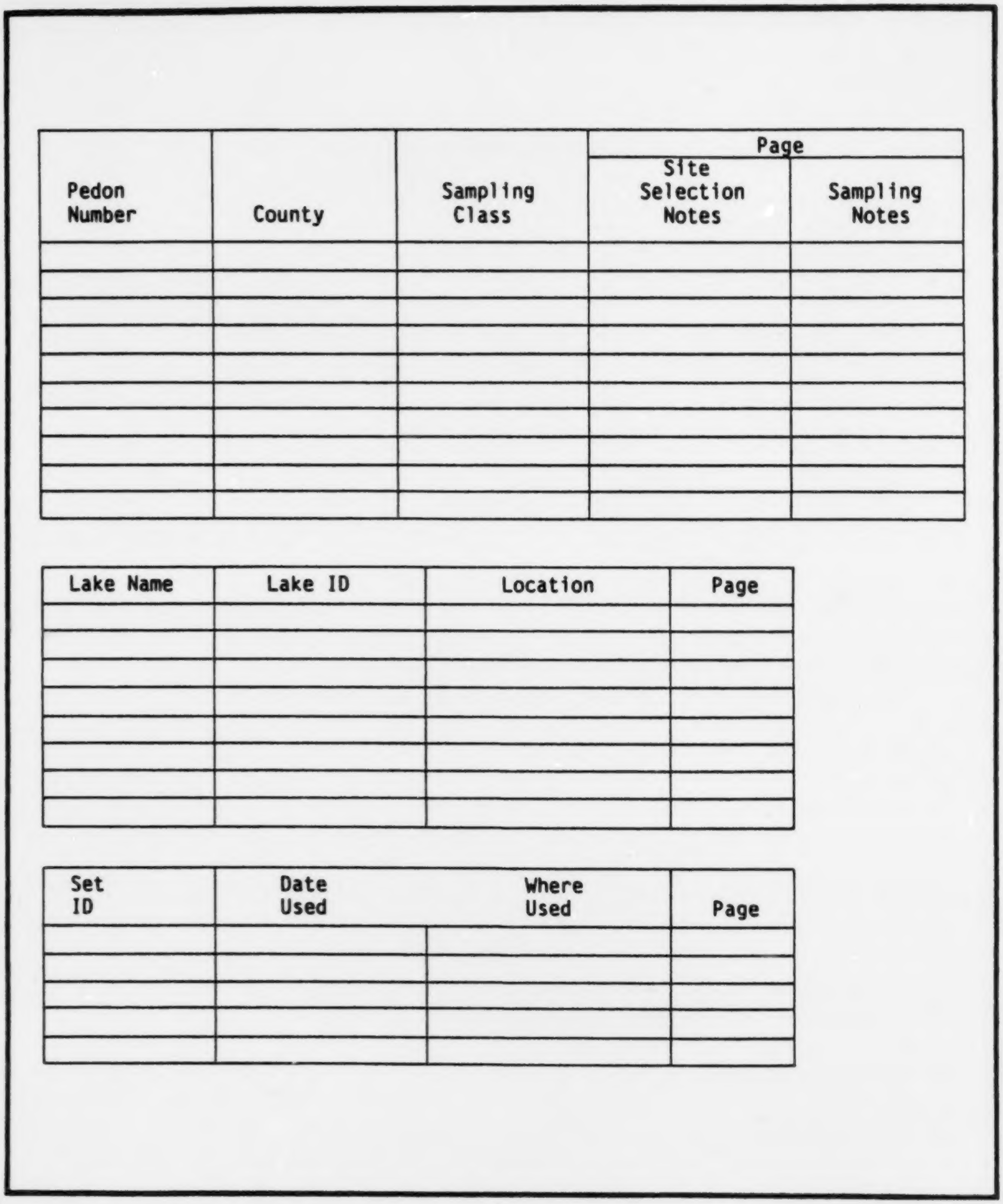
____ Page in Logbook of
Notes Taken During
Audit

Who: ______________________ Date: ________________

_____________________________ ________________ ____________________

_____________________________ ________________ ____________________

Figure 3. Recommended title page for sampling log books



Pedon Number	County	Sampling Class	Page	
			Site Selection Notes	Sampling Notes

Lake Name	Lake ID	Location	Page

Set ID	Date Used	Where Used	Page

Figure 4. Recommended index page for sampling log books

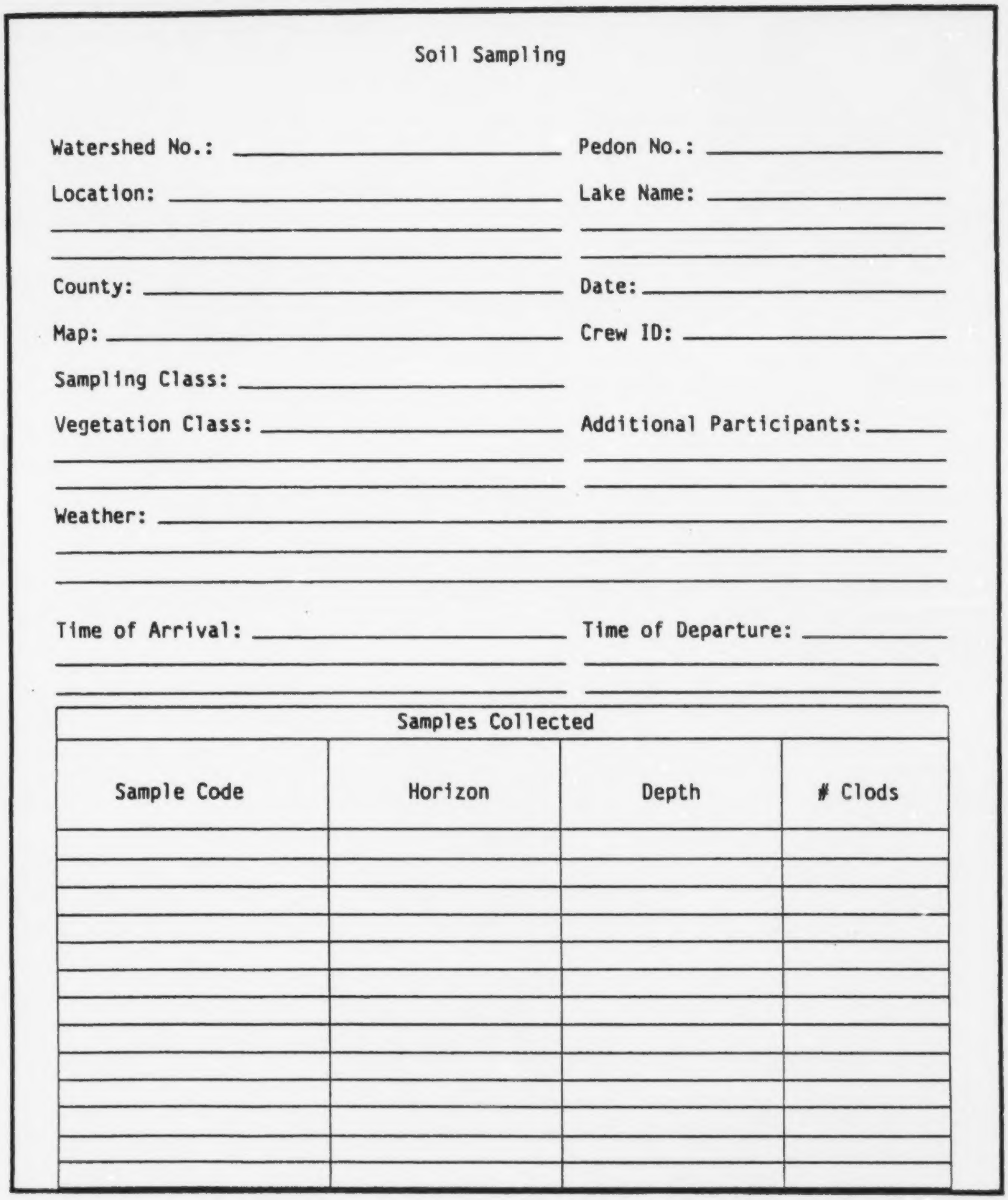
Site Selection

Watershed No.: ____________________	Pedon No.: ______________
Location: ________________________ ________________________________ ________________________________	Lake Name: ______________ ________________________ ________________________
County: __________________________	Date: ___________________
Map: _____________________________	Crew ID: ________________
Sampling Class: ___________________	
Vegetation Class: __________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________	Additional Participants: ____ ________________________ ________________________ ________________________ ________________________ ________________________

Site Location Notes: ____
____
____
____

Point 1: ____
____
____
____
____
____
____
____
____
____
____

Figure 5. Recommended format for site location notes



Soil Sampling

Watershed No.: ____________ Pedon No.: ____________

Location: ____________ Lake Name: ____________

County: ____________ Date: ____________

Map: ____________ Crew ID: ____________

Sampling Class: ____________

Vegetation Class: ____________ Additional Participants: ____________

Weather: ____________

Time of Arrival: ____________ Time of Departure: ____________

Samples Collected

Sample Code	Horizon	Depth	# Clods

Figure 6. Recommended format for sampling notes

Notes: ______________________________

Sample Storage: ______________________________

Sample Transport to Prep Lab: ______________________________

Figure 6 (continued)

Film Roll #	Slide #	WS ID	WS Name	Sampling Class	Slide Description

Figure 7. Recommended format for slide key

slides. A master slide list could be generated by each sampling crew, and could be included in each slide catalog submitted to EPA at the conclusion of the survey.

Sampling log books should contain the following types of information to further increase their value as reference documents:

- An index of log book entries.
- Notes detailing equipment and supply needs.
- Notes on the function and use of field equipment.
- Names and phone numbers of all sampling crew members, SCS state staff, preparation laboratory personnel, and others associated with the sampling operations.
- Comparisons of paired pedon descriptions, particularly noting similarities and differences.
- Complete records of the clod sampling procedure, including horizons successfully sampled, the number of clods obtained from each horizon, and reasons clods could not be obtained from unsampled horizons.
- Visits by RCC, SCS state staff, and QA auditors, including documentation of issues and concerns discussed.
- Difficulties encountered in site location or soil sampling activities, particularly those that could have an adverse effect on the quality of samples or data collected.
- Comments concerning protocol adherence or modification.

Sample Receipt Log Books

The variability of information recorded in the sample receipt log books suggests that a standard format would be desirable to ensure that useful sample receipt information is recorded. This documentation includes the date, time, and person delivering the sample in addition to information identifying each sample as a unique entity. All samples delivered to the preparation laboratory should be logged in, including clod samples. A record of field duplicates and paired pedon samples would be useful for later data summary. A suggested format for sample receipt log books is provided in Figure 8. The many column headers needed to record all necessary data suggest that an 11- by 14-inch notebook would be most useful. Columns must be wide enough to allow data to be entered legibly.

Sampling crews should record directly on the sample bag label any information that may be important in the handling of the sample by the preparation laboratory, e.g., unsieved samples, or that may affect the quality of the sample, e.g., leaking gel-pacs in the styrofoam coolers. This type of information should be transferred to the sample receipt log book under "Sample Condition."

Sampling crews should ensure that sample receipt log book entries are transcribed directly from the sample bag label, i.e., Label A, rather than from the sampling log book or field data form. In this way, the presence of each sample that is entered in the log book can be verified as the samples are logged.

									Sample Condition	Additional Notes		
Sample Number	Crew ID	Site ID	Set ID	Date Collected	Date Received	Time Received	Delivered By	Received By	Wet/Dry (W/D) Sieved/Unsieved (S/U) Bag Split (BS) Under Volume (UV)	Number of Clod Samples Collected for Each Horizon Sampled	Field Duplicate?	Paired Pedon?

Figure 8. Recommended format for sample receipt log books

Preparation laboratory personnel are responsible for verifying that a sample exists for each sample code that has been entered in the logbook.

Paired Pedon Descriptions

For the benefit of the sampling crews, the protocols should explain the purpose of paired pedon sampling.

Independent Pedon Descriptions

It is recommended that the protocols for future surveys specifically indicate that all independent pedon descriptions must be performed in the same portion of the pedon. The pedon should be marked to clearly delineate the profile for description. If descriptions are not performed in the same locations, it should be clearly noted on the field data form. Independent pedon description comparisons yield little useful information unless the exact portion of the same profile is described.

The independent field descriptions should be reviewed among all participants while still in the field so differences and discrepancies can be discussed and documented at that time for the benefit of the data users. The objective is not to reach a consensus on the best description, but is to provide an exchange of information concerning the inherent variability among describers and the characterization of soil development features.

CONCLUSIONS

Generally, soil sampling activities proceeded as planned within the expected time frame. The sampling methods and quality assurance activities developed for use in the SBRP soil survey ensured the collection of soil samples of known and documented quality. The coordination of sampling activities among the many participants was a large-scale, complex task that was successfully performed as originally conceived with a minimum of unanticipated difficulties and modifications. A number of recommendations have been made in this report to assist planners of similar projects.

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APPENDIX A

SAMPLING PROTOCOLS FOR THE SOUTHERN BLUE RIDGE PROVINCE SOIL SURVEY

by

L. J. Blume, M. L. Papp, K. A. Cappo, J. K. Bartz, D. S. Coffey, and K. Thornton

The following protocols were used by sampling crews during the Southern Blue Ridge Province Soil Survey. The protocols were distributed to DDRP participants as the draft "Soil Sampling and Preparation Laboratory Manual for the Direct/Delayed Response Project Soil Survey." The draft did not undergo a complete external review and was not formally released by EPA. Parts I and II of the draft are presented here without editorial correction. The reader may notice that various Soil Conservation Service documents were used in the preparation of this draft, however, because no editorial corrections have been made, those documents are not cited.

Part III of the draft contains the protocols used by the preparation laboratories, and is included as Appendix A in Volume II of this report, referenced as follows:

Haren, M. F., and R. D. Van Remortel. 1987. Direct/Delayed Response Project: Field Operations and Quality Assurance Report for Soil Sampling and Preparation in the Southern Blue Ridge Province of the United States, Volume II: Preparation. U. S. Environmental Protection Agency, Las Vegas, Nevada.

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PART I. OVERVIEW

1.0 INTRODUCTION

This field sampling manual is written to guide personnel involved in the collection and preparation of soil samples for the Direct/Delayed Response Project (DDRP) Soil Survey of the Environmental Protection Agency (EPA). All field and laboratory personnel must be trained by a field manager or by other persons knowledgeable in the procedures and protocol detailed in this manual. The scope of this manual includes field operations, preparation of samples for analysis, analytical procedures performed at the preparation laboratory, and formation and shipment of batches to contractor laboratories.

This manual is a companion to the Laboratory Methods Manual for the Direct Delayed Response Project Soil Survey and the Quality Assurance Project Plan for the Direct Delayed Response Project Soil Survey. There is some repetition among the manuals which is necessary to maintain continuity and to document the methodology of the Soil Survey.

The basic goals of the DDRP Soil Survey procedures are to collect representative samples without contamination, to preserve sample integrity for analysis, and to analyze samples correctly. Procedures have been chosen that offer the best balance among precision, accuracy, sensitivity, and the needs of the data user.

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The overall objective of DDRP is to predict the long-term response of watersheds and surface waters to acidic deposition. Based upon this research, each watershed system will be classified according to the time scale in which it will reach an acidic steady state, given current levels of deposition. Three classes of watershed systems are defined:

> Direct response systems: Watersheds with surface waters that either are presently acidic (alkalinity <0) or will become acidic within a few (3 to 4) mean water residence times (<10 years).
>
> Delayed response systems: Watersheds in which surface waters will become acidic in the time frame of a few mean residence times to several decades (10 to 100 years).
>
> Capacity protected systems: Watersheds in which surface waters will not become acidic for centuries to millennia.

The DDRP is managed by the technical director at the EPA Environmental Research Laboratory - Corvallis (ERL-C). The sampling task leader at ERL-C has overall responsibility for the sampling phase including QA/QC. The quality assurance (QA) manager at the EPA Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV) has responsibility for logistical and analytical QA support.

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The objective of this manual is to emphasize and modify National Cooperative Soil Survey (NCSS) procedures as is necessary to characterize and sample soils for the DDRP Soil Survey. This manual is written to an audience of soil scientists who are aware of NCSS procedures and who have experience in soil description, soil sampling, and laboratory preparation. Since this manual supplements NCSS handbooks and manuals, one should refer to those documents for more complete description and definitions.

Soils which have been identified in the sampling regions have been combined into groups, or sampling classes, which are either known to have or are expected to have similar chemical and physical characteristics. Each of the sampling classes can then be sampled across a number of watersheds in which they occur. Note that in this approach, a given soil sample does not represent the specific watershed from which it came. Instead it contributes to a set of samples which collectively represent a specific sampling class on all DDRP watersheds within the sampling region.

The manual is a guide to soil sampling of routine pedons. Protocols for sampling special interest watershed pedons are contained in another document supplied by ERL-C.

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PART II. FIELD OPERATIONS

2.0 FIELD PERSONNEL AND EQUIPMENT

2.1 Personnel

2.1.1 Field Crews - A field crew consists of one crew leader who is a soil scientist experienced in the National Cooperative Soil Survey (NCSS) and two to three other crew members who may also be soil scientists. Crews from each state are numbered consecutively beginning with 01. For example, if state XY has three crews, they are XY01, XY02, and XY03. The lead soil scientist in each crew will supervise all field operations and decisions. This person is also responsible for selecting each sampling site and for documenting all field data. The field crew leader has the responsibility to

- Obtain samples from the soil classes selected for characterization.
- Make decisions concerning soil description and sampling including horizon delineation, horizon thickness, and material excluded from the samples.
- Ensure that site and pedon descriptions, logbooks, and pedon labels are legible and accurate and that photographs are taken properly.
- Ensure proper use and maintenance of field equipment, including cleaning between each sample.

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- Minimize contamination of the sample particularly from soil or solution found above or below the horizon being sampled.
- Maintain sample integrity until delivery to the preparation laboratory.
- Report to the Sampling Task Leader (at the earliest possible opportunity) any problems or difficulties encountered while sampling or transporting soil samples.
- Return all unused field equipment and supplies to the preparation laboratories.

2.1.2 USDA Soil Conservation Service, Soils Staff for each state - A representative of the Soil Conservation Service (SCS) State Soils Staff will independently describe a minimum of one site per field crew. These independent pedon descriptions will be used to assess the variability in site descriptions among soil scientists. This representative will also monitor adherence to protocol for site selection, labeling, and sampling. The representative will make his assessment while the crew is describing and sampling the pedons. Written reviews will be documented and submitted to the Environmental Research Laboratory - Corvallis (ERL-C) within two (2) weeks. Major problems must be reported orally within two (2) days.

2.1.3 Regional Coordinator/Correlator - The Regional Coordinator/Correlator (RCC) must be a qualified soil scientist with several years experience

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in soil profile description and soil mapping. The RCC will also monitor one site per field crew for adherence to NCSS standards, procedures, and sampling protocol modifications as presented in this document and will perform an independent duplicate profile description. At least one site in each state will be monitored with the SCS State Soils Staff representative while the remaining sites may be monitored independently. The RCC will also ensure that State Soils Staff perform duplicate profile descriptions. During this process, the RCC will identify, discuss, and resolve any significant problems. Written reports are submitted to ERL-C within two (2) weeks. The resolution of major problems must be reported orally within two (2) days.

2.1.4 Quality Assurance/Quality Control Representative - The quality assurance/ quality control (QA/QC) representative will audit each field sampling crew at least once to ensure adherence to sampling protocol as specified in this manual and to fulfill ERL-C auditing requirements. Written reports will be submitted to ERL-C within two (2) weeks. Major problems will be reported orally within two (2) days.

2.2 Field Equipment

The materials required to successfully complete the sampling task are listed in the following six sections. Materials marked with an asterisk (*) are supplied by the EPA through the preparation laboratory. Unmarked

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materials must be supplied by the crew. Equipment not specifically listed may be considered optional. Obtain permission from the QA manager before using optional equipment. It is the crew leader's responsibility to see that all EPA-issued equipment and supplies shall be returned to the preparation laboratory upon completion of the study. This includes all durable equipment and unused consumables.

2.2.1 Site Selection Equipment -

- Screw auger
- Bucket auger
- Aerial photographs
- Stereoscope
- Compass (true north, adjust for declination)
- Punch probe
- Spade
- Topographic site map
- Map showing sampling sites (provided by ERL-C)
- Random number table

2.2.2 Excavation Equipment -

- Shovels
- Spades (sharpshooters)

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- Picks/Mattock
- Hand pump (Beckson Gusher - 16 GPM)*
- Post hole digger
- Backhoe

2.2.3 Soil Description Equipment -

- SCS-232 form (one per site)*
- Letter size tablet holder
- 5.25" double-sided double-density computer disks
- Munsell color chart (newly purchased or in good condition)
- 2 clinometers
- Compass (true north, adjust for declination)
- Hand lens
- Hand knife
- pH kit
- Peat sampler (for Histosols)
- Orange flagging (1 roll/day)*
- Yellow marker flags (5/site)*
- Indelible ink markers (black)*
- Golf tees (for horizon delineation in photographs)
- Plastic squeeze bottle (for wetting soils)

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2.2.4 Photographic Equipment -

- 35-mm camera, fully automated with flash*
- Ektachrome ASA-200 slide film
- Prepaid Kodak mailing envelopes
- Photogray cards*
- Khaki cloth measuring tape (5 cm x 2 m) with clearly marked black figures at 50-cm intervals and tick marks at 10-cm intervals (supplied by ERL-C)
- Slidefile (for archiving slides)

2.2.5 Clod Sampling Equipment -

- Dow Saran-310 resin*
- Acetone
- 1 gallon metal paint can with lid (saran storage)*
- Hair nets (1/clod)*
- 6" x 8" Plastic bags, 1 mil (1/clod)*
- 17.50" x 11.94" x 3.75" Clod box, 24-cell (1 box/day-reusable)*
- 2" x 2" blank vinyl labels (attach to box to identify each clod compartment)*
- Rope (for hanging clods)
- Clothespins or hooks (for hanging clods)
- Hand knife
- Scissors

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- Pruners
- Fine mist spray bottle

2.2.6 Sampling Equipment -

- Post hole digger (for Histosols only)
- 1 brass sieve (19-mm)*
- 1 gallon plastic bucket
- Spatula or putty knife (for sampling thin horizons)
- Plastic sheet, 6 mil (1.2 m x 1.2 m)*
- Stiff brush (for cleaning sieves and plastic)
- Plastic inner bags (20/day)*
- Cloth exterior bags (20/day)*
- NADSS Label A (30/day)*
- Staplers (1 heavy duty, 1 standard)*
- Staples*
- Dust pan
- Hand trowel
- Rubber tipped pestles (for sieving soils)

2.2.7 Transportation Equipment -

- Packs (Indian packs or backpacks)
- Styrofoam coolers (3/day)*
- Gel packs (24/day or 8/cooler)*

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- Thermometers, centigrade (2)*
- Truck or car with covered cargo area

2.3 Use of Field Equipment

How a crew decides to utilize its equipment determines the quality of the soil sample recovered. Careful use of the proper equipment coupled with cleanliness will reduce contamination of the samples. Sections 3, 4, 5, and 6 describe the use of the equipment in the field.

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3.0 SELECTION OF PEDON TO BE SAMPLED

3.1 Identifying a Suitable Pedon for Sampling

Components of soil map units (including inclusions) have been grouped into soil sampling classes which are either known to have or are expected to have similar chemical and physical characteristics for the purposes of the DDRP Soil Survey. The soil sampling classes for the Southern Blue Ridge Province sampling effort are shown in Figure 3.1, and a list of the soil components identified from soil mapping is in Appendix (E). The soil sampling classes and components for the northeastern sampling effort are found in Appendix F.

Soil sampling sites were selected as locations where one would expect to find a combination of a soil pedon that represents a soil sampling class and a specified vegetation class. The site locations were randomly selected from soil maps and vegetation maps of the DDRP watersheds. Since each sampling site for a specified soil sampling class was located within a map polygon having a representative of the sampling class as a soil map unit component, one would expect to find a soil pedon that fits the sampling class in the near vicinity of the randomly selected point. An example using soils typical of the Southern Blue Ridge Province is used for illustration. The actual sampling classes used will depend on the area of study. For example, if one were to sample a pedon that represented

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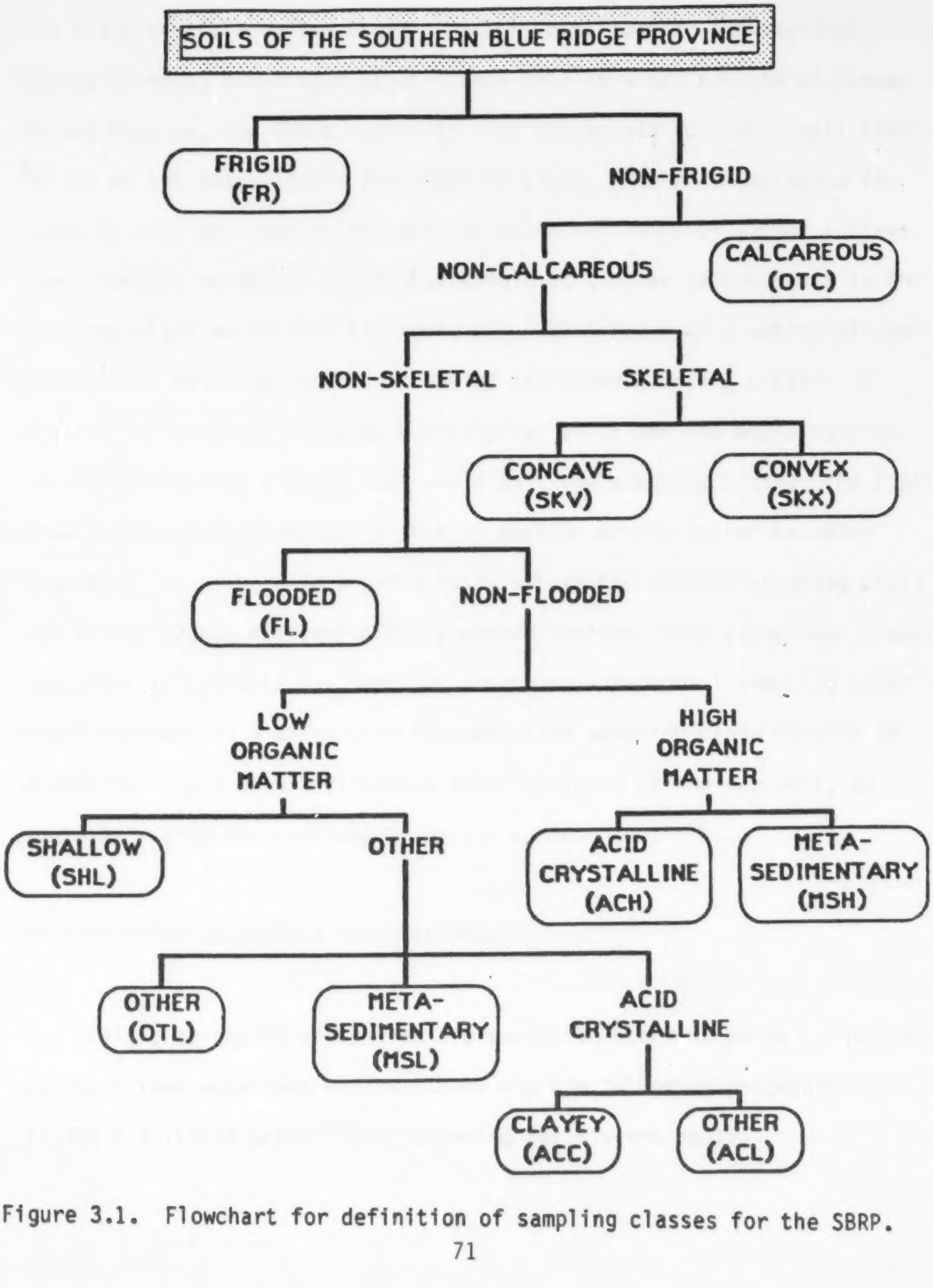
SOILS OF THE SOUTHERN BLUE RIDGE PROVINCE
FRIGID (FR)
NON-FRIGID
NON-CALCAREOUS
CALCAREOUS (OTC)
NON-SKELETAL
SKELETAL
CONCAVE (SKV)
CONVEX (SKX)
FLOODED (FL)
NON-FLOODED
LOW ORGANIC MATTER
HIGH ORGANIC MATTER
SHALLOW (SHL)
OTHER
ACID CRYSTALLINE (ACH)
META-SEDIMENTARY (MSH)
OTHER (OTL)
META-SEDIMENTARY (MSL)
ACID CRYSTALLINE
CLAYEY (ACC)
OTHER (ACL)

Figure 3.1. Flowchart for definition of sampling classes for the SBRP.

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the class of shallow, low organic matter, non-flooded, non-skeletal, non-calcareous, non-frigid soils (class SHL) in a map polygon of Cowee-Saluda Complex, one would expect to find the Saluda soil or a soil similar to one of the soils in the SHL sampling class. The pedon selected for sampling does not need to fit all the characteristics of either a Cleveland, Ramsey, or Saluda series but should be similar to the soils in the sampling class as defined in Figure 3.1. If a pedon at a potential sampling point would better fit in one of the other sampling classes in Figure 3.1, the soil would be a dissimilar soil, and one would need to search further for a pedon that would suit the sampling class. The field crew leader decides whether a soil is similar or dissimilar by using Figure 3.1 as a key. If a pedon falls within the desired sampling class and if the nearby vegetation falls within the specified vegetation class, the pedon is suitable for sampling. Because a potential sampling point might not fall on a pedon with the specified sampling class because of dissimilar soils or miscellaneous areas included in the map unit, an unbiased procedure is needed to locate a pedon that fits.

3.2 Procedure for Locating a Suitable Pedon

The field crew should proceed to a preselected starting point identified by ERL-C from watershed soil maps and use the following procedure to locate a suitable pedon. The following definitions apply:

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Sampling site - A circle with a 150-m radius whose origin corresponds to one of the ordered points indicated on the watershed soil map supplied by ERL-C prior to sampling activities.

Potential sampling point - A circle with a 5-m radius which can be searched for the preselected soil class and vegetation class.

Starting point - The first potential sampling point located at the center of each sampling site.

Procedure

Step 1: Obtain a map that clearly shows the five preselected ordered random points.

Step 2: Go to the starting point of the first potential sampling site indicated on the map. If that starting point is inaccessible but some part of the sampling site is accessible, follow the procedure in Step 4 to select the location of the pedon for sampling. If the entire sampling site is inaccessible or unsuitable, note the reasons on the SCS-232

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Field Form and proceed to the second or next potential sampling site.

Some land use classes generally are not suitable for sampling. These classes include urban land, barren land, and waste disposal land. The crew leader will decide if a sampling site is unsuitable.

Step 3: If the starting point is accessible and fits the specified soil class and vegetation class, sample the pedon.

Step 4: If the starting point is accessible but does not contain the specified soil class or vegetation class, then the following site selection procedures are required:

- From a random-number table, select a random number between 1 and 8 (where 1 is northeast, 2 is east, and so forth).
- Transect potential sampling points in 10 m intervals along a 150 m straight line in the chosen direction until the first occurrence of the proper combination of soil class and vegetation class is found. If a proper combination of soil class and vegetation class is not obtained after five transects (a total of 76 potential

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sampling points), go to the next highest numbered potential sampling site on the list.

- Record on the SCS-232 form in the log section the direction of each transect and the number of the sampling point (do not record meters) on the last transect. Use N for north, NE for northeast and so forth. An example could be: SW, N, E, SE-7.
- If none of the five potential sampling sites yield an accessible pedon with the specified vegetation class and soil class, record this information in the field notebook and call the Sampling Task Leader at the earliest possible convenience.

3.3 Locating a Suitable Pedon of a Map Unit Inclusion

Where insufficient map polygons are available to sample the soil class from major map unit components, the pedons must be sampled from map unit inclusions. Some of the pedons for the calcareous (OTC) sampling class will be collected from inclusions. To locate a suitable pedon for sampling from an inclusion, go to an area nearest the preselected sampling site within the map polygon where a soil that fits the class is expected to be located. If a suitable pedon cannot be located near the first sample site, go to the next site.

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3.4 Paired Pedons

Paired pedons are satellite pedons sampled in conjunction with the corresponding routine pedon. (Paired pedons are selected by sampling class and watershed and are selected and assigned in advance by ERL-C).

The crew leader determines the location of the paired pedon based on the following criteria:

- Sufficient distance between the two sampling locations to avoid disturbance of the paired pedon from sampling of the routine pedon.
- The same sampling class and vegetation class as the routine pedon.
- The same slope position as the routine pedon.
- Protocol is the same for describing, sampling, and coding as for routine pedons.

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4.0 PEDON EXCAVATION

In order to describe and sample a pedon as specified in the site description section, the field crew must excavate a pit that exposes at least one clean vertical face, a minimum of 1 m horizontally, to bedrock or to the depth specified for the region.

A decision regarding which face to describe is made before the excavation has started so that neither soil from the pit nor human activity disturbs the soil or surface litter on that side.

If the soil is not stable and is a danger to members of the crew, do not excavate a standard pit. Excavate the pit in standard form as deeply and safely as possible. After this, the crew leader decides how further to proceed in the excavation, description, and sampling.

4.1 Standard Excavation (level to gently sloping ground)

4.1.1 Pit Size - There are many methods available for excavating a sampling pit. The standard excavation method described in this subsection is practical in most soil sampling situations.

The preferred initial size of the pit is at least 1 meter by 2 meters (see Figure 4.1). It is desirable to use these dimensions both to

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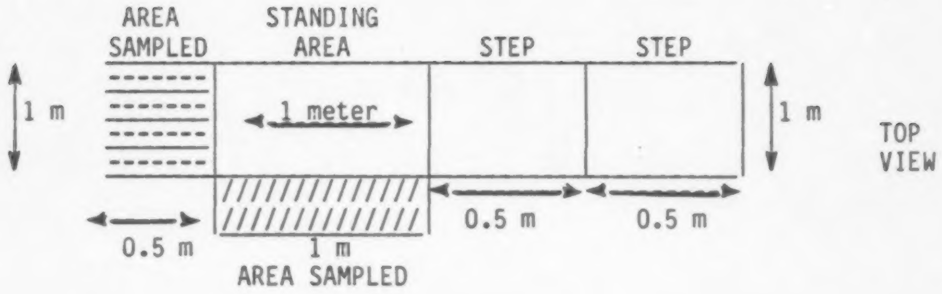

Figure 4.1. Pit design for standard excavation (on level to gently sloping ground) - top view.

observe the soil throughout the range of its characteristics and to obtain representative samples; however, modifications of this method may be required to fit a specific situation.

4.1.2 Steps in the Pit - When the pit is excavated to a depth of 50 to 70 cm, a step may be incorporated (see Figure 4.2). Steps may be repeated every 50 to 70 cm until a depth of 1.5 to 2.0 or more meters is attained or until bedrock is reached. The steps allow the soil scientist to continue digging a pit large enough for proper characterization of the pedon; they also allow access for describing and sampling the pedon.

4.2 Excavation of Soils with Water Tables

The description and sampling of soils with water tables may require special methods of excavation.

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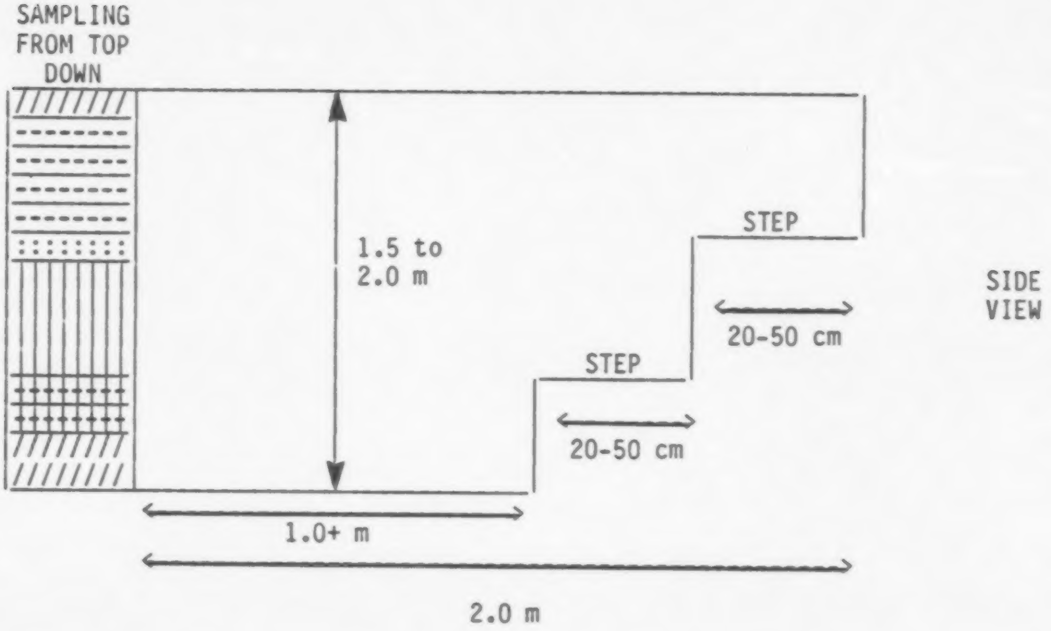

Figure 4.2. Pit design for standard excavation (on level to gently sloping ground) - side view.

A sump may be dug in a corner away from the face to be described and sampled. Water may be removed from the sump by bailing or pumping as necessary. It may be desirable to describe and sample lower horizons first in order to reduce contamination of the sample and to minimize water removal effort.

Sumps may be dug upstream of the flow of the water table. Use the bucket auger, peat sampler, or other implement to dig a hole that will collect the flowing ground water before it enters the pit. In flat areas with no discernible direction of ground-water flow, it may be necessary to dig

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sacrificial holes on all sides of the pit in order to drain the local water table before the pit can be described and sampled.

A pit in lowlands with a high water table is difficult to sample. If the previous options do not result in a clean, dry pedon face, allow the local water table to drain into the pit for a period of time, while pumping continuously, until the local water table is fairly well drained. Continue using the hand pump and direct its outflow away from the pit as much as possible. When the inflow of water is reduced to a manageable level, then describe and sample the pedon.

4.3 Excavation of Organic Soils

Organic pedons cannot readily be excavated in standard form. As a result, organic pedons may be described by using a peat sampler and may be sampled with a posthole digger.

4.4 Soils Difficult to Excavate

In cases where the C horizon material is extremely difficult to excavate, (i.e., lithic and paralithic contacts) a depth of 1/2 meter less than the specified depth, although not desirable, is acceptable. The field crew leader decides if the soil is too difficult to dig through. Document this decision on the SCS-232 form.

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5.0 SITE AND PROFILE DESCRIPTION

Complete descriptions of the soils are essential to the soil survey and serve as a basis for soil identification, classification, correlation, and interpretation. Standards and guidelines are necessary for describing soil properties. Precisely defined standard terms are needed if different observers are to record data uniformly. However, the field scientist must evaluate the adequacy of standard terms and must add needed information.

The description of a body of soil in the field, whether the body is an entire pedon or a sample within a pedon, records the types of soil horizons, their depth and thickness, and the properties of each horizon. These properties include color; texture; structure; consistence; the presence of roots, animals, and their traces; reaction characteristics; the types of salts present; and features of the boundaries between layers. Some of the properties which apply to the entire sampling unit are also measured and recorded. Generally, external features are observed throughout the extent of the polypedon; internal features are observed from studying a pedon that is within the desired sampling class.

For a soil description to be of greatest value, the part of the landscape that the pedon represents should be recorded. The description should include external and internal features of the soil, related features such as vegetation and climate, and geomorphic position, and landform.

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Pedons selected for detailed study are chosen tentatively at first. The areas chosen for description and sampling are areas that previous mapping has shown to contain the sampling class of interest. The pedon is usually selected on the basis of external evidence. Once a tentative sampling site is located, the soil is examined to verify that it satisfies the criteria for the sampling class.

5.1 Profile Preparation

Clean the sides of the pit of all loose material disturbed by digging. Examine the exposed vertical faces, starting at the top and working downward. Identify significant differences in any soil chemical or physical properties that distinguish between adjacent layers. Identify and mark the boundaries between horizons on the face of the pit. Photographic documentation should take place before the pedon face is disturbed by description and sampling.

5.2 Photographs of Profile and Site

Photographic documentation of the sampling point and soil pedon is useful for later reference and to complement field descriptions. Field crews will be provided with a 35-mm camera. Ektachrome, ASA-200 slide film will be purchased locally. If available, tripods should be included in the photographic equipment. For film-quality consistency, all slides should be developed using the Kodak process.

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Photographic documentation requires that a precise logbook be kept to identify slides. The indexing system can be developed by the field crew, but it must be based on the sample code from NADSS Label A to identify the site. The system used must be fully explained in the logbook.

Photograph in this order for each site sampled: pedon face, tree canopy above the pit, understory vegetation in the immediate vicinity of the pit, representative landscape or landform and any outstanding features of the pedon or sampling site. Identify the pedon being photographed by including NADSS Label A information on the photogray cards provided. Place the photogray card at the top of the pedon pit (on top of the profile) when taking the photograph. Note in the field log the order of the photos taken so the slides can be correctly labeled later. Place a khaki cloth tape marked with large black markings at 10-cm intervals and numbers at every half meter in photographs of the pedon face. Note that the Khaki measuring tape is made to be placed at the left of the profile because of the way the intervals are marked. Place an object for scale in understory vegetation photographs. Photograph organic soil pedons by sequential placement of the peat sampler increments on the ground or plastic; include the khaki cloth tape in the photograph. Reconstruct the pedon in sequential order, and place the cloth tape at the top of the profile.

In order to produce a quality slide, equal lighting of the whole pedon face is important. If some areas of the face are lit by full sunlight and

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others are shadowed by trees, the slides will exhibit exposure problems and the boundaries between layers will be indistinguishable. If this problem arises, shade the entire pedon face for uniform exposure and use a flash. Natural sunlight and shaded photos are both necessary for adequate documentation. Try to avoid extremely oblique photo angles. The objective is to document the pedon and the site. Take as many photos as necessary to accomplish this goal.

Once the slides have been developed, they should be labeled on the slide mounts with the sample code, what the slide is, and any other information the field crew deems necessary. Slides are stored in three-ring binders in slide files and are submitted with the logbook to EPA-LV at the conclusion of the sampling phase of the survey. Slidebooks and logbooks will be sent to the QA/QC personnel listed at the end of this section. Slide numbers are also to be recorded in the log section of the 232 Form (page 4 of 4). Use care in handling cameras and film. Avoid excessive heat and sunlight.

5.3 Thick Horizons

Sometimes a horizon or layer designated by a single combination of letters needs to be subdivided. Subdivision occurs at 30 centimeters in horizons above 1 meter and 60 centimeters in horizons below 1 meter.

These layers need to be identified, and this is done simply by

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numbering each subdivision consecutively within a layer having a unique symbol, starting at the top. For example, four layers of a Bt horizon sampled by 10-cm increments would be designated Bt1, Bt2, Bt3, and Bt4 (SSM p. 4-47). The four samples would be identified by a unique horizon designation and by therefore, a unique sampling code.

5.4 Field Descriptions

Descriptions should be completed before sampling although changes may occur during the sampling process. To observe horizontal relationships between soil features, expose a cross section of each layer by removing the soil above the layer. Each horizontal section must be large enough to expose any structural units. A great deal more about a layer is apparent when it is viewed from above, in horizontal section, as well as in vertical section. Structural units that are otherwise not obvious, as well as the third dimension of many other features, should be observed and recorded. Patterns of color within structural units, variations of particle size from the outside to the inside of structural units, the pattern in which roots penetrate structural units, and similar features are often seen in horizontal section more clearly than in a vertical exposure.
To complete the field description, the field crew will use Form SCS-SOI-232 which is coded for easy input onto a computerized data file. The protocol for horizon description is discussed in detail in the SCS National Soils Handbook,[1] the SCS Soil Survey Manual,[2] Principles and

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Procedures for Using Soil Survey Laboratory Data,[3] and The National Handbook of Plant Names.[4] The SCS 232 form is reproduced along with instructions and codes in Appendix C. Vegetation codes from the National Handbook of Plant Names should be used.

The SCS 232 form information will then be transferred into a computer data file via the program developed by SCS National Soil Survey Laboratory and will be revised into a dBASE III format by ORNL. The data entry instructions and program will be provided to the SCS in each state by Oak Ridge National Laboratory (ORNL). The program will not require dBASE III software since formatting has been internalized on the disk. The program has a built-in data-entry verification procedure which will permit only valid parameter codes to be entered. Disks with the SCS 232 form information and a copy of the SCS 232 forms will be sent to the personnel specified in Section 5.5.

5.5 Documents

Documentation will be sent to the following personnel:

SCS-232, Disks, Slides, and Logbooks

Mike Papp - Associate Soil Scientist
Lockheed Engineering and
Management Services Company, Inc.
1050 E. Flamingo, Suite 200
Las Vegas, Nevada 89109

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One copy of SCS-232 to Oak Ridge National Laboratory (ORNL) to:

SCS-232, Disks

Julia Watts - Data Manager, DDRP
Oak Ridge National Laboratory
P.O. Box X
Building 1505, Room 348
Oak Ridge, Tennessee 37831

and one copy to the EPA ERL-C to:

SCS-232, Disks

Jeff Lee - Soil Sampling Task Leader
Environmental Research Laboratory-Corvallis
200 S.W. 35th Street
Corvallis, Oregon 97333

6.0 FIELD SAMPLING PROCEDURES

One of the objectives of field sampling is to collect a soil sample from each horizon that will yield a minimum of 2-kg of air-dried soil material that passes a 2 mm sieve. Clods are collected to determine field bulk density.

6.1 Sampling the Pedon

6.1.1 Field Sampling Protocol - Field sampling protocol is based on NCSS standard methods. The following procedural steps were developed by the National Soil Survey Laboratory, Lincoln, Nebraska, and are detailed in SCS (1984b). Field crews should be familiar with the content of this document before field sampling begins. An edited version of these procedures follows.

6.1.2 Important Points Concerning Soil Sampling - The sample site should be free of road dust and chemical contamination. Record in the field sampling logbook all known spraying of pesticides and herbicides.

Soil samples should be collected from major horizons to bedrock or to a specific depth from freshly dug pits that expose a clean vertical face about 1 m wide.

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Samples are taken from continuous horizons ≥3 cm thick, including the C horizon if present. Discontinuous horizons or a horizon <3 cm thick is sampled when considered significant by the crew leader.

From each mineral horizon sampled, collect three fist-sized clods from each horizon sampled for bulk density determination. Adherence to all items listed in Section 6.4 is necessary.

6.2 Sample Size

After the sampling site has been excavated, photographed, and described, horizon sampling begins. A minimum of 2 kg of air-dried soil material that passes a 2 mm sieve is necessary to complete all chemical and physical analyses. Therefore, a sample volume of approximately 1 gallon (about 5.5 kg) of mineral soil material that passes a 19 mm sieve is required. If the estimated volume of the 2- to 19-mm size rock fragments exceeds 45 percent, more sample is needed (2 kg for every 10 percent increase over 45 percent). Two full sample bags of organic horizon material are requested in every case possible. It may be difficult to obtain one gallon of uncontaminated sample from a thin horizon (<3 cm). In this case it is recommended that as much soil material be collected as possible, given time constraints, while maintaining the integrity of the horizon. The preparation laboratory determines whether enough sample has been taken for adequate processing; they will notify the field crews if problems occur.

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6.3 Sampling Procedure

Horizons should be sampled in a sequence that minimizes sample contamination and that is most practical. Sampling may expose spatial variability that was not accounted for in the initial profile description. Descriptions should be modified to reflect this situation.

Sampling the Oi horizon is not necessary. Depending on the thickness of the Oe and Oa, they may be sampled separately or together. Thin surface layers may be sampled from an uncontaminated area within a few meters of the pedon.

Pass the field sample through a 19-mm sieve. The preparation laboratory will determine the percent rock fragments in the 2- to 20-mm fraction. Place the soil fraction passing the 19-mm sieve in the sample bag according to the procedures given in Section 6.5.

The sampling party needs to be alert to taxonomic questions that may arise and needs to sample appropriately to resolve the questions (e.g., base saturation for Alfisol versus Ultisol may require subsampling at a specific depth). Appropriate sampling increments depend on the kind of material and on the proximity of the horizon to the soil surface. Horizons in the upper 1 m are split for sampling if they are more than 30 cm thick, excluding organic horizons. Uniform horizons below 1 m are split for sampling

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if they are more than 60 cm thick. The ideal sample contains each soil material within the horizon in proportion to its occurrence in the pedon.

6.3.1 Stratified Horizons - A single horizon may contain several thin strata. When the thin contrasting strata cannot be readily separated for sampling, composite the strata into one sample for the horizon. Each soil material should be described, and the proportions should be recorded. The soil material should then be sampled in those proportions. Note stratified horizons in the free form notes on the SCS 232 form.

6.3.2 Field Duplicates - Sample one horizon per day in duplicate. This will be the field duplicate. Different horizons should be chosen from day to day so that all horizons are duplicated during sampling.

To obtain a true horizon duplicate, alternate trowel-fulls or dust-pan loads into 2 piles or into 1-gallon buckets. Sieve and place in separate sample bags; label one as a routine sample and the other as a field duplicate. (See Section 6.6 and Figure 6.4 for labeling instructions.)

6.4 Sampling Clods for Bulk-Density Determination

Bulk density is defined as the mass per unit volume of soil. Bulk density

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is determined from soil clods collected from each mineral horizon and coated in the field with saran to preserve their integrity.

This method was chosen because of its routine use in the field, relative ease of performance, and elimination of compaction problems inherent in core methods. Clods cannot readily be obtained from some horizons.

6.4.1 Procedure - Collect natural clods (three per horizon) of about 100 cm^3 to 200 cm^3 in volume (approximately fist-size). Remove a chunk of soil larger than the clod from the face of a sampling pit with a spade. From this piece, prepare a clod by gently cutting or breaking off protruding peaks and material sheared by the spade. If roots are present, they can be cut conveniently with scissors or side cutters. In some soils, clods can be removed directly from the face of the pit with a knife, spatula, or hand trowel. No procedure for taking samples will fit all soils; the procedure must be adjusted to meet the conditions in the field at the time of sampling using appropriate equipment.

Place the clods in hairnets and suspend them from a rope hung out like a clothesline. Label the clods with the tags supplied, and attach the tags to the hairnet. On the label record the site ID, sample code, horizon, depth, and replicate number (1, 2 or 3). Coding of this information is discussed in Section 6.6. Moisten dry clods with a fine mist spray; this will inhibit saran from entering air spaces of the clod.

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Dip the suspended clods by raising a container of the saran mixture upward to submerse each clod momentarily (2 seconds). It is recommended to dip clods once. If it is necessary to dip clods more than once note the number of times on the clod label. Allow the saran-coated clods to dry for 15 minutes or until dry to touch.

6.4.2 Transport of Clods - Place clods in 6" x 8" plastic bags, seal bags with a twist-tie, and place in the compartmentalized clod boxes. The top (inner face) of the clod box should be labeled with the same information as on the clod tag (i.e., sample code, horizon, replicate number, and how many times the clod was dipped in the resin mixture if dipped more than once). Take great care to ensure that the clods are not broken or damaged during handling and shipping. Fill the space in each compartment not occupied by the clods with packing material, i.e., leaves, grass, etc.

6.5 Filling Sample Bag

Place approximately 1 gallon or more of soil that has passed the 19-mm sieve in each plastic sample bag. The actual amount of soil available for chemical analysis is highly dependent on the amount of rock fragments contained in each horizon (Section 6.2).

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Label plastic sample bags with NADSS Label A. Attach the label to the center of the bag and not near the top of the bag. Check that all designations are correct, complete, and legible. Do not include large, easily removed nonmineral material in the sample. Limit handling of the soil sample to avoid contamination. Excess water in Histosols should be drained before sealing the sample bag. Do not drain water from mineral soils. This will prevent the loss of the fine particle size fraction.

Fold down the top of the plastic sample bag in 2-cm sections. Staple the folded sections to sufficiently seal the bag.

Place each sealed plastic bag within a canvas bag. With indelible ink, label the canvas bag below the center with exactly the same information contained on NADSS Label A. Seal the canvas bag by tying. The soil samples must be placed in a 4°C temperature storage area within 24 hours but every effort should be made to keep the soils cool and dry after the samples have been excavated. If a sampling crew is returning to a cold storage facility each night, using gel packs is not necessary; storage within the coolers for transport is acceptable. If a crew plans to be in the field for longer than 24 hours, the frozen gel packs or Blue Ice will be necessary. Store as many frozen gel packs in one cooler as possible when transporting to the sampling site. This will keep the gel packs frozen longer. A cooler can be sufficient for eight gel packs and a maximum of four sample bags. Ten coolers may suffice a field crew for a

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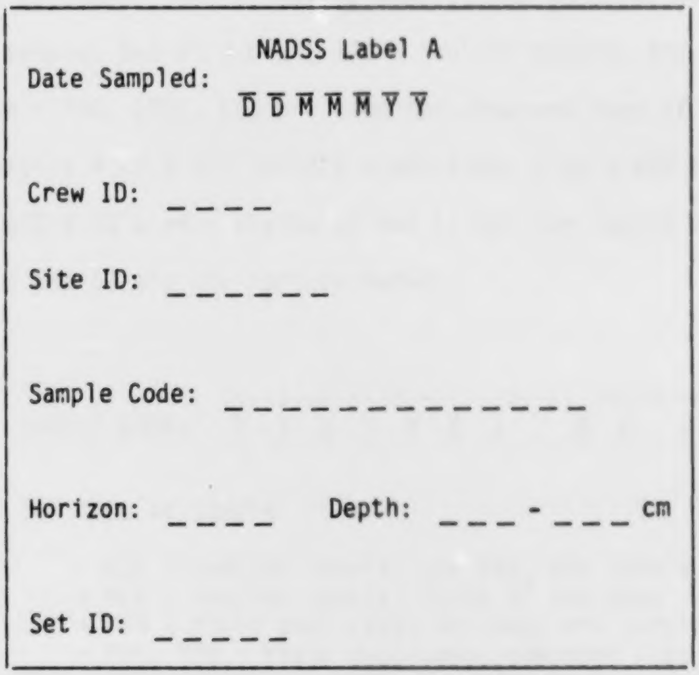
week, taking into account that the last day's samples may be left unrefrigerated for 24 hours. Coolers containing gel packs and soil samples should be taped shut before transit.

6.6 NADSS Label A



NADSS Label A

Date Sampled: D D M M M Y Y

Crew ID: _ _ _ _

Site ID: _ _ _ _ _ _

Sample Code: _ _ _ _ _ _ _ _ _ _ _ _ _

Horizon: _ _ _ _ Depth: _ _ _ - _ _ _ cm

Set ID: _ _ _ _ _

Figure 6.1. NADSS Label A.

The sample date is entered in the format DD MMM YY. For example, March 14, 1985, is 1 4 M A R 8 5. The crew identification (ID) consists of four digits: the first two are alphabetic, representing the state, and the second two are the crew number assigned to each field crew for the state.

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An example of a crew ID is NC01. The site ID is synonymous with watershed ID and appears on the assigned watershed map.

The sample code represents the SCS (FIPS) soil ID code and the sample type. Any soil that is to be analyzed separately must be identified by a unique sample code. The first three digits of the sample code represent the type of sample (R11 = routine sample, one bag, one sample; R23 = routine sample, 2nd of 3 bags; R33 = routine sample, 3rd of 3 bags; Field Duplicate = FD0, [FD1, FD2 are used for compound bags of field duplicates], etc.), digits 4 to 5 are the SCS state code, 6 to 8 are the SCS county code, digit 9 is a zero digits 10 and 11 are the county pedon number, and digits 12 and 13 are the horizon number.

```
              |<--1-->|<--2-->|<--3-->| |<--4-->|<--5-->|
SAMPLE CODE:   R  1  1  T  N  0  1  7  0  0   2   0  4
```

1. Type of Sample
    - R11 - routine sample, one bag, one sample
    - R12 - routine sample, first of two bags
    - FD0 - Field duplicate, one bag, one sample
    - FD1, FD2 - Field duplicate, compound bags
2. SCS State Code
3. SCS County Code
4. County Pedon Number (decided by SCS state office)
5. Horizon Number (designated on SCS 232 form)

Figure 6.2. Sample code.

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The horizon and depth line represents the information described in the horizon designation and depth parameters of the SCS 232 form. If two organic horizons are combined (see 6.2), sample codes and horizon codes must be written on the NADSS label A for both horizons, i.e.,

Sample Code: R12NC019-0302
R12NC019-0303

Horizon: Oe 0-2 cm
Oa 2-6 cm

The set ID is a four-digit number. A unique set ID number is used every day the sampling crew samples a pedon. The set ID's will be assigned.

Much of the information recorded on the canvas bags, NADSS label A, and on the clod tags can be pre-labeled the day before sampling of the pedon occurs, i.e., the date, crew ID, site ID, a portion of the sample code, and the set ID. The crew leader must have the pedon site located or be fairly confident the site will be found. This pre-labeling will ensure legibility, especially in wet condition, and will free a sampling crew member for other tasks at the sampling site. The following are labeling examples.

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 1 1 T N 0 1 7 0 0 3 0 6

Horizon: C _ _ _ Depth: 1 4 0 - 2 0 0 cm

Set ID: 0 2 0 9 9

Figure 6.3. Single horizon.

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: F D 0 T N 0 1 7 0 0 3 0 6

Horizon: C _ _ _ Depth: 1 4 0 - 2 0 0 cm

Set ID: 0 2 0 9 9

Figure 6.4. Field duplicate horizon.

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NADSS Label A

Date Sampled: 1 1 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 1 2 T N 0 1 7 0 0 4 0 2
R 1 2 T N 0 1 7 0 0 4 0 3

Horizon: 0 e _ _
0 a

Depth: 0 0 0 - 0 0 5
0 0 2 - 0 0 5

Set ID: 0 2 0 0 1

NADSS Label A

Date Sampled: 1 1 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 2 2 T N 0 1 7 0 0 4 0 2
R 2 2 T N 0 1 7 0 0 4 0 3

Horizon: 0 e _ _
0 a

Depth: 0 0 0 - 0 0 2 cm
0 0 2 - 0 0 5

Set ID: 0 2 0 0 1

Figure 6.5. Combined horizon.

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NADSS Label A

Date Sampled: 10APR86
DDMMMYY

Crew ID: TN01

Site ID: 2A07907

Sample Code: R12TN01700302

Horizon: Oe__ Depth: 000 - 005 cm

Set ID: 02099

NADSS Label A

Date Sampled: 10APR86
DDMMMYY

Crew ID: TN01

Site ID: 2A07907

Sample Code: R22TN01700302

Horizon: Oe__ Depth: 000 - 005 cm

Set ID: 02099

Figure 6.6. Horizon requiring two sampling bags.

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6.7 Delivery

The soil samples are delivered to the preassigned soil preparation laboratory.

Because of the location of some watersheds, some samples may not be delivered to the preparation laboratory until three to four days after they are sampled. Every effort should be made to get the field samples to the preparation laboratory as soon as possible. Great care should be taken not to drop or puncture sample bags in transport to the preparation laboratory. If major problems occur, notice must be given as soon as possible to the Sampling Task Leader.

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12.0 REFERENCES

1. USDA/SCS. 1983. National Soils Handbook. Part 600-606. U.S. Government Printing Office, Washington D.C.

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APPENDIX A

STRATEGY OF SITE SELECTION AND SAMPLING INFORMATION FOR THE NORTHEASTERN UNITED STATES

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1.0 SELECTION OF WATERSHEDS

Because the objectives of the Direct/Delayed Response Project (DDRP) Soil Survey are focused on making regional inferences, it was critical that the 150 watersheds selected for mapping of soils and watershed characteristics constitute a representative sample of the region. The 773 watersheds included in Region I of the National Surface Water Survey (NSWS) provided an excellent starting point from which to draw a subsample of 150 for the Northeastern study of the DDRP because (1) the NSWS lakes were selected according to a rigorous probability sampling method, i.e., stratified by five subregions and three alkalinity classes within each subregion and because (2) water chemistry information was available from NSWS for these lakes.

The 150 watersheds studied in the DDRP also are part of the Phase II Lake Monitoring Program of the NSWS that will provide a data set that contains both water-chemistry and watershed information. Therefore, the procedure used to select these watersheds incorporated criteria relevant to both the DDRP and the NSWS. The procedure consisted of five steps, which are summarized as follows:

Step 1: Lakes of low interest, e.g., too shallow, highly enriched, capacity protected, polluted by local activities, or physically disturbed, were excluded.

Step 2: Lakes too large to be sampled, i.e., >200 ha, were excluded.

Step 3: A cluster analysis was performed on a set of chemical and physical variables to group the remaining 510 lakes into three clusters of lakes with similar characteristics.

Step 4: A subsample of 60 lakes was selected from each cluster; the three subsamples were weighted to represent the overall population of lakes in the Northeast.

Step 5: Lakes with watersheds too large to be mapped at the required level of detail, i.e., watersheds >300 ha, were excluded from the subsamples.

This procedure identified 148 lakes and watersheds spread across the three clusters. Note that the three groups differ primarily in their alkalinities, pH levels, and calcium concentrations. To maintain the ability to regionalize conclusions drawn on the sample of 148 watersheds, the precision of information characterizing each of these watersheds should be comparable, and each cluster should be described at the same level of detail as the others.

2.0 SOILS MAPPING

During the spring and summer of 1985, 145 of the 148 watersheds were mapped. The logistics and protocols of the watershed mapping are described in Chapters 6 and 7, Volume 5, Appendix B.2 Soil Survey -- Action Plan/ Implementation Protocol.

A total of about 440 mapping units were identified in the 148 watersheds. Sampling each of the 440 mapping units would not necessarily be the best way to describe adequately the chemistry of the soils of the region. A better procedure is to combine the identified soils into groups or sampling classes which are either known to have or are expected to have similar chemical characteristics. Each of these sampling classes can then be sampled across a number of watersheds in which it occurs, and the mean characteristics of the sampling class can be computed. The mean values and the variance about the mean can then be used to construct area- or volume-weighted estimates of the characteristics of each watershed.

For this procedure to work, it is necessary that a sufficient number of samples are taken, i.e., five or more, to characterize the variability of each sampling class. This necessitates aggregating the number of mapping units into a reasonable number of sampling classes, given budgetary constraints. Thus, the central goal is to develop a method of grouping the large number of soils into a reasonable number of sampling classes.

3.0 SAMPLING CLASSES

3.1 Data Base

The data base contains about 2200 observations that were recorded on the field forms during the soil mapping of 145 watersheds selected as part of the DDRP and the Phase II lakes survey. This information includes

Soil taxonomic class (series, subgroup, great group)
Family texture
Parent material
- Origin
- Mode of deposition

Drainage class
Slope class
Slope configuration
Geomorphic position
Dominant landform
Surface stoniness
Percent inclusions
Percent of soils occurring in complexes
Estimated depth to bedrock
Estimated depth to permeable material

This information was considered in aggregating similar mapping units into sampling classes. The data base also includes the area of each mapping unit, the number of occurrences, and the percent of the watershed area.

Separate data files also exist for vegetation type, vegetation class, and geology. The data management system, dBase III, runs on an IBM PC-XT microcomputer at the EPA Environmental Research Laboratory in Corvallis, Oregon (ERL-C).

3.2 Evaluation of Sampling Classes

A taxonomic approach was used to identify 38 sampling classes as a foundation for aggregating similar mapping units. Taxonomic classification is based on similarities among soil properties. This taxonomic scheme was modified to reflect the major factors thought to influence soil chemistry.

4.0 WATERSHED AND SAMPLING CLASS SELECTION

4.1 Sampling Class Objectives

The primary goal of this part of the sample selection procedure is to determine which sampling classes will be sampled in which watersheds. The sites should be selected to meet the following objectives:

Objective 1: To characterize all the sampling classes with similar levels of precision.

Objective 2: To describe the variation in watershed characteristics.

Objective 3: To describe the variation in the Acid Neutralizing Capacity (ANC) clusters developed from the lake survey.

4.2 Sampling Class Constraints

To meet these three objectives, a series of constraints was developed based on the allocation of samples to sampling classes and watersheds. The constraints that must be met follow:

Constraint 1: Approximately equal numbers of samples will be taken from each sampling class.

Constraint 2: Approximately two samples will be taken from each watershed.

Constraint 3: Not more than one sample will be taken from each sampling class in each watershed.

Constraint 4: Samples will be selected over the range of ANC clusters within each sampling class.

The method outlined here was developed to randomly select watersheds and sampling classes within these constraints by using a simple selection algorithm.

4.3 Selection Algorithm

The method selection proceeds through a series of stages. Wherever possible, the rationale for the particular approach taken is described and is cross-referenced with the objectives and constraints.

The selection method is based on the use of a systematic, weighted random sample of the watersheds that contain any given sampling class. First, the number of samples to be taken in each sampling class is determined (constraint 1).

4.3.1 The first task is to construct a matrix of the occurrences of each sampling class in each watershed. This matrix is used to (1) prepare a list of the watersheds that contain each sampling class, and (2) determine the number of different sampling classes in each watershed.

When the number of watersheds represented in each sampling class has been determined, it is possible to allocate the samples to sampling classes (given constraint 3).

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Using eight samples per sampling class as a base, the following sample allocation occurs. Eight samples will be allocated to each sampling class when there are more than eight watersheds; when there are eight or fewer watersheds, one sample will be allocated to each watershed.

4.3.2 The next task is to determine which watersheds will be selected within each sampling class. In this process, constraints 2 and 4 are centrally important.

If watersheds are selected randomly within each sampling class, the watersheds that contain a large number of sampling classes will have more samples allocated to them than will the watersheds that have few sampling classes. To counteract this effect, and to help approach an approximately equal number of samples per watershed, the watersheds will be weighted (during the random selection procedure) by the inverse of the number of sampling classes that they contain.

For example, if one watershed contains four different sampling classes, it will be exposed to the sample selection procedure four times. Thus, it will be given one quarter of the weight of a watershed that contains only one sampling class. By using this technique, both watersheds have an approximately equal probability of being selected. This scheme will work accurately if there are equal numbers of watersheds considered in each sampling class; the presence of unequal numbers will cause some deviation from the most desirable distribution of samples.

To avoid overemphasizing the very common soils, only one sample will be taken from each watershed that contains only one sampling class. All named soils in a complex soil series are counted as occurrences in their respective sampling classes. For example, a Tunbridge-Lyman soil complex in a watershed mapping unit would be considered as one occurrence of sampling class S12 which contains the Tunbridge series and as one occurrence of sampling class S13 which contains the Lyman series.

The method used to select watersheds within sampling classes will be to sort the watersheds by ANC cluster and then take a systematic, weighted random sample using the weights described above. This procedure selects a random starting point in the list of watersheds and then selects watersheds at regular intervals from the (weighted) list. This method ensures a selection across the range of ANC clusters.

To ensure that a watershed is not sampled more than once for a given sampling class, the weight assigned should not be larger than the interval used in the systematic sampling. Weights should be scaled down if they exceed the systematic sampling interval.

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4.3.3 Once this procedure has been followed for each sampling class, the initial selection of watersheds and sampling classes can be summarized. Three options are possible at this point.

The weighting factors can be adjusted iteratively until the allocation is acceptable.

Samples can be arbitrarily moved among watersheds to reach the desired allocation.

The selection can be accepted as adequate.

If the selection is not considered adequate, the most acceptable solution is to repeat the procedure using adjusted weights. This process could be automated, if necessary, with the weight of a watershed being increased until the watershed receives sufficient samples.

The method of sampling class and watershed selection outlined here is designed to satisfy the objectives and constraints listed in Sections 5.4.1 and 5.4.2. Given the nature of the constraints, it is likely that there is no single, perfect solution; however, this method allows the production of an acceptable selection that is a compromise among the demands of the different objectives.

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5.0 FINAL SAMPLING LOCATIONS

5.1 Rationale and Objectives

Soil surveys generally have a single purpose of describing the typical soil series or soil phases found in a watershed. The DDRP is interested in obtaining samples that are integrative or that represent the sampling class in the watershed. This sampling class may contain six or seven similar soils. The sampling purpose is to describe the characteristics of the sampling class rather than the characteristics of a specific soil phase. Because all soils within a sampling class are considered similar in soil chemistry, the specific sampling location within a sampling class can be selected at random with respect to the soil series. The procedures described in this section are intended (1) to characterize the range of variability that occurs within a sampling class and (2) to characterize the soils within a sampling class by using similar levels of precision.

Determining the sampling location within the watershed sampling class is a two-step process.

5.2 Sampling Site Selection

There are five steps in selecting representative sampling sites within a sampling class.

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NOTE: Steps 1 through 5 will be completed by ERL-C. Maps that show the five random points, as discussed in step 3, will be given to each SCS field crew.

Step 1: Prepare a list of all mapping units and the sampling class or classes in which they occur. Most mapping units will occur only in one sampling class; complexes may occur in two or more sampling classes. For each complex, record the proportion of area occupied by each soil series in the complex (from the mapping unit description). This proportion should be the average proportion excluding the area occupied by inclusions.

Step 2: For each watershed, obtain the watershed maps and identify the sampling classes selected for that watershed. Mapping-unit delineations for each soil series must be aggregated and identified for each sampling class.

Step 3: Transfer a grid that has a cell size of about 1 hectare to a Mylar sheet. Overlay the grid on the watershed map. Select a set of random coordinates (by using a computer program) and determine if the point they represent intersects one of the sampling classes selected on that watershed. If the point does not fall within the selected sampling class, draw another pair of random coordinates. Continue this process until five random points have

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been identified in each sampling class. Record their order of selection from 1 through 5. Some sampling locations may not be accessible, therefore, alternate locations must be provided.

Step 4: If the point falls on a sampling unit that is a complex, draw a random number, Y, between zero and the total percentage of the soils in the complex (e.g., a 50-30 percent complex of Tunbridge-Lyman would sum to 80, so the maximum random number is 80). Determine the percentage of the area in the desired sampling class (e.g., Tunbridge is 50 percent). Call this number X. If X is less than Y, draw another set of coordinates. This procedure minimizes the probability that complexes will be overselected for sampling.

Step 5: For each location selected, overlay appropriate maps and note the vegetation class associated with each point as (1) coniferous, (2) deciduous, (3) mixed, (4) open dryland, or (5) open wetland.

NOTE: For a comparison of coniferous, deciduous, and mixed vegetation types with Society of American Foresters (SAF) forest cover types, see Table 1.

TABLE 1. COMPARISON OF CONIFEROUS, DECIDUOUS, AND MIXED VEGETATION TYPES TO SAF FOREST COVER TYPES

SAF Cover Type Name	Cover Type Number
Coniferous Vegetation Types	
Jack Pine	1
Balsam Fir	5
Black Spruce	12
Black Spruce - Tamarack	13
White Spruce	107
Tamarack	38
Red Spruce	32
Red Spruce - Balsam Fir	33
Red Spruce - Frasier Fir	34
Northern White Cedar	37
Red Pine	15
Eastern White Pine	21
White Pine - Hemlock	22
Eastern Hemlock	23
Deciduous Vegetation Types	
Aspen	16
Pin Cherry	17
Paper Birch	18
Sugar Maple	27
Sugar Maple - Beech - Yellow Birch	25
Sugar Maple - Basswood	26
Black Cherry - Maple	28
Hawthorn	109
Gray Birch - Red Maple	19
Beech - Sugar Maple	60
Red Maple	108
Northern Pin Oak	14
Black Ash - American Elm - Red Maple	39
Mixed Vegetation Types	
Hemlock - Yellow Birch	24
Red Spruce - Yellow Birch	30
Paper Birch - Red Spruce - Balsam Fir	35
White Pine - Chestnut Oak	51
White Pine - Northern Red Oak - Red Maple	20

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Within the sampling class, pedons that have one or more of the soils in the sampling class and that have one or more of the vegetation classes noted above will be sampled.

6.0 MISCELLANEOUS SAMPLING INFORMATION FOR THE NORTHEASTERN SAMPLING EFFORT

This manual is written as a generic document that can be used in various sampling efforts. The following information identifies specific protocols that were used in the initial Northeastern Sampling Effort identified by "a" after the number. Items identified by "b" after the number reflect protocols that are currently being used in the DDRP sampling effort of the Southeastern United States. Some of these changes are results of lessons learned whereas other changes reflect differences resulting from the physical nature of the soils in the various regions.

6.1 Personnel

6.1.1a Field Sampling Crews - The field sampling crew will consist of soil scientists experienced in the NCSS.

6.1.1b Field Sampling Crews - A field sampling crew consists of one crew leader who is a soil scientist experienced in the NCSS and two to three other crew members who may also be soil scientists.

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6.1.2a Regional Coordinator Correlator - The Regional Coordinator Correlator will monitor 6 to 10 percent of the sampling units.

6.1.2b Regional Coordinator Correlator - The Regional Coordinator Correlator will monitor one site per field crew.

6.1.3a SCS State Office Staff - The state staff will independently describe 5 to 10 percent of the sampling units.

6.1.3b SCS State Office Staff - The state staff will independently describe one site per field crew.

6.1.4a QA/QC Auditor - The QA/QC auditor will review 5 percent of the sampling units.

6.1.4b QA/QC Auditor - The QA/QC auditor will audit each sampling crew.

6.2 Site Selection

6.2.1a Step Two - The sampling crew will go to the location of the first potential sampling site indicated on the map. If that location is inaccessible, go to the second potential sampling site on the list.

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6.2.1b Step Two - Go to the starting point of the first potential sampling site indicated on the map. If the starting point is inaccessible but if some part of the sampling site is accessible, follow the procedure in step 4 to select the location of the pedon for sampling.

6.2.2a Step Three - If the randomly selected site contains a soil series that is not a member of the sampling class or if the vegetation class is not applicable, select a random number from a random number table between 1 and 8 where 1 represents the direction north, 2 = northeast, and so forth. Walk along a straight line in that direction and check in 20 ft. sections until the first occurrence of the proper combination of soil series and vegetation class is found. The maximum distance walked corresponds to a radius of 500 feet around the selected site.

6.2.2b Step Three - If the starting point is accessible but does not contain the specified soil class or vegetation class, then the following site selection procedures are required.

- From a random number table, select a random number between 1 and 8 (where 1 represents north, 2 = northeast, and so forth).

- Transect potential sampling points in 10 meter intervals along a 150 meter straight line until the first occurrence of the proper combination of soil and vegetation class is found.

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6.3 Rock Fragments

6.3.1a Size Codes

2 - 75 mm
75 - 250 mm
>250 mm

6.3.1b Size Codes

20 - 76 mm
76 - 250 mm
>250 mm

6.4 Field Duplicate

6.4.1a One horizon per day will be sampled twice by each field crew. The choice of which horizon to duplicate is at the discretion of the field crew.

6.4.1b Different horizons should be chosen from day to day so that all horizons are duplicated during sampling.

6.5 Sampling

6.5.1a Uniform horizons below 1 meter are normally split for sampling if they are greater than 75 cm.

6.5.1b Uniform horizons below 1 meter are split for sampling. If they are greater than 60 cm, they are given a new horizon designation. For example, four layers of a Bt horizon sampled by 30 cm increments would be designated Bt1, Bt2, Bt3, and Bt4. The four samples would be identified by a unique horizon designation and, therefore, a unique sampling code.

6.6 Set Identification Codes and Crew Codes*

Crew Code	Set ID
ME01	0 - 099
ME02	100 - 199
ME03	200 - 299
NH01	300 - 399
NY01	400 - 499
NY02	500 - 599
NY03	600 - 699
MA01	700 - 799
MA02	800 - 899
CT01	900 - 999
PA01	1000 - 1099
VT01	1100 - 1199

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* A definition of these codes and their uses is supplied in Section 6.6 of the text.

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APPENDIX B

STRATEGY OF SITE SELECTION AND SAMPLING INFORMATION FOR THE SOUTHEASTERN UNITED STATES

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1.0 SELECTION OF WATERSHEDS

A two-stage sampling design was used to select streams for Phase I of the National Stream Survey. In the first stage of selection, a grid (with a scaled grid size of 64 km^2) was placed over a map of the Southern Blue Ridge Province, and the streams closest (going downslope) to each grid point were selected. These selections provided information on the frequency distribution of reach lengths and watershed areas in the study region. In the second stage, the streams from every other grid point were used to select reaches for chemical measurements. The probability of selecting a given stream and reach is known. Therefore, chemical measurements on a sample of reaches can be extrapolated back to the overall region.

Fifty-one watersheds in the Southern Blue Ridge Province are being sampled in the Phase I Stream Survey. Only 37 of these watersheds, however, have areas less that 3000 ha. Only these watersheds will be sampled in the Soil Survey.

1.1 Sampling Site Selection

There are five steps in selecting potential sampling sites for a sampling class on a watershed. These five steps are:

1.1.1 Identify the watersheds on which each sampling class is to be sampled. For each watershed and sampling class, identify the map units in which the sampling class occurs. Calculate the percentage of the map unit in the sampling class from the map unit description.

1.1.2 For each watershed, obtain the watershed maps and identify the sampling classes selected for that watershed. For each desired sampling class, delineate areas of occurrence by aggregating delineations of map units that contain the sampling class.

1.1.3 Randomly orient a grid overlay on the watershed map. Number the points on the grid that fall within the delineation of the selected sampling class, beginning at the upper right of the grid. Select 5 random numbers between 1 and the number of grid points in the sampling class, recording the order of selection of the 5 numbers. Mark five points on the watershed map, and associate with each point its order of selection.

1.1.4 If the point falls on a map unit that is a complex, then draw a random number, say Y, between 0 and the total percent of the named soils in the complex (e.g., 50 to 30 percent complex of Tunbridge-Lyman would sum to 80 so the maximum random number is 80). Determine the percent of the area in the desired sampling class, e.g., Tunbridge is 50 percent. Call this number X. If X is less than Y (i.e., $X < Y$), draw another set of coordinates. This procedure minimizes the probability that complexes will be overselected for sampling.

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1.1.5 Overlay the soil map with the vegetation map and, for each location selected, note the vegetation class associated with each point as one of the following.

- Coniferous
- Deciduous
- Mixed
- Open dryland
- Open wetland

Pedons will be sampled in areas within delineation of the sampling class that have any of the soils in the sampling class and the vegetation class noted above.

1.2 Set Identification Codes and Crew Codes*

Crew Code	Set ID
TN01	2000 - 2099
TN02	2100 - 2199
TN03	2200 - 2299
NC01	2300 - 2399
NC02	2400 - 2499
NC03	2500 - 2599
NC04	2600 - 2699
GA01	2700 - 2799
GA02	2800 - 2899
VA01	2900 - 2999

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* A definition of these codes and their uses is supplied in Section 6.6 of the text.

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APPENDIX C

FIELD DATA FORMS AND LEGENDS

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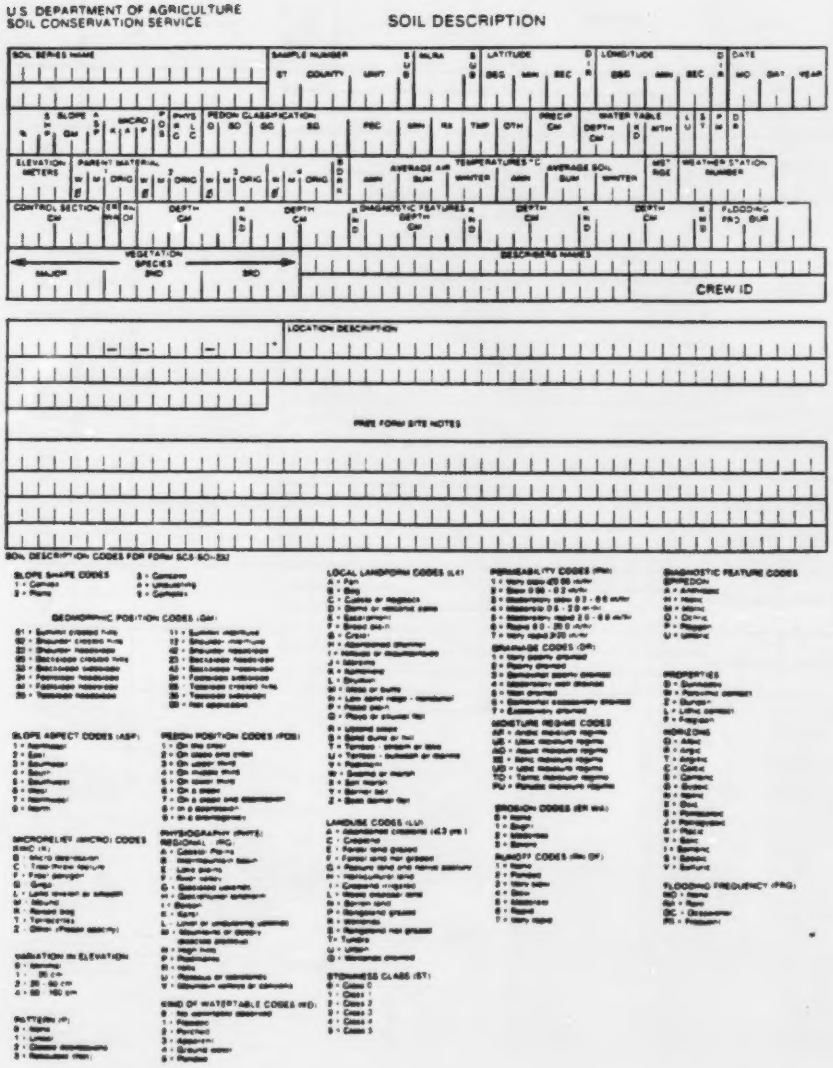
FORM SCS-SOI-232



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL DESCRIPTION

SOIL SERIES NAME
SAMPLE NUMBER: ST, COUNTY, UNIT, SUB
MLRA, SUB
LATITUDE: DEG, MIN, SEC, DIR
LONGITUDE: DEG, MIN, SEC, DIR
DATE: MO, DAY, YEAR
SLOPE, CM, ASP, MICRO: K, A, P, POS, PHYS: RG, LC
PEDON CLASSIFICATION: O, SO, GG, SG, FEC, MIN, RX, TMP, OTH
PRECIP CM
WATER TABLE: DEPTH CM, KD, MTH
LU, ST, PM, DR
ELEVATION METERS
PARENT MATERIAL: W, M, ORIG (1, 2, 3, 4)
BDRK
TEMPERATURES °C: AVERAGE AIR: ANN, SUM, WINTER; AVERAGE SOIL: ANN, SUM, WINTER
MST RGE
WEATHER STATION NUMBER
CONTROL SECTION CM, ER, RN OF
DEPTH CM, KND
DIAGNOSTIC FEATURES: DEPTH CM, KND
FLOODING: FRQ, DUR
VEGETATION SPECIES: MAJOR, 2ND, 3RD
DESCRIBERS NAMES
CREW ID
LOCATION DESCRIPTION
FREE FORM SITE NOTES

SOIL DESCRIPTION CODES FOR FORM SCS-SOI-232

SLOPE SHAPE CODES
GEOMORPHIC POSITION CODES (GM)
SLOPE ASPECT CODES (ASP)
PEDON POSITION CODES (POS)
MICRORELIEF (MICRO) CODES
PHYSIOGRAPHY (PHYS) REGIONAL (RG)
VARIATION IN ELEVATION
PATTERN (P)
KIND OF WATERTABLE CODES (KD)
LOCAL LANDFORM CODES (LL)
LANDUSE CODES (LU)
STONINESS CLASS (ST)
0 = Class 0
1 = Class 1
2 = Class 2
3 = Class 3
4 = Class 4
5 = Class 5
PERMEABILITY CODES (PM)
DRAINAGE CODES (DR)
MOISTURE REGIME CODES
EROSION CODES (ER WA)
RUNOFF CODES (RN OF)
DIAGNOSTIC FEATURE CODES
EPIPEDON
PROPERTIES
HORIZONS
FLOODING FREQUENCY (FRQ)

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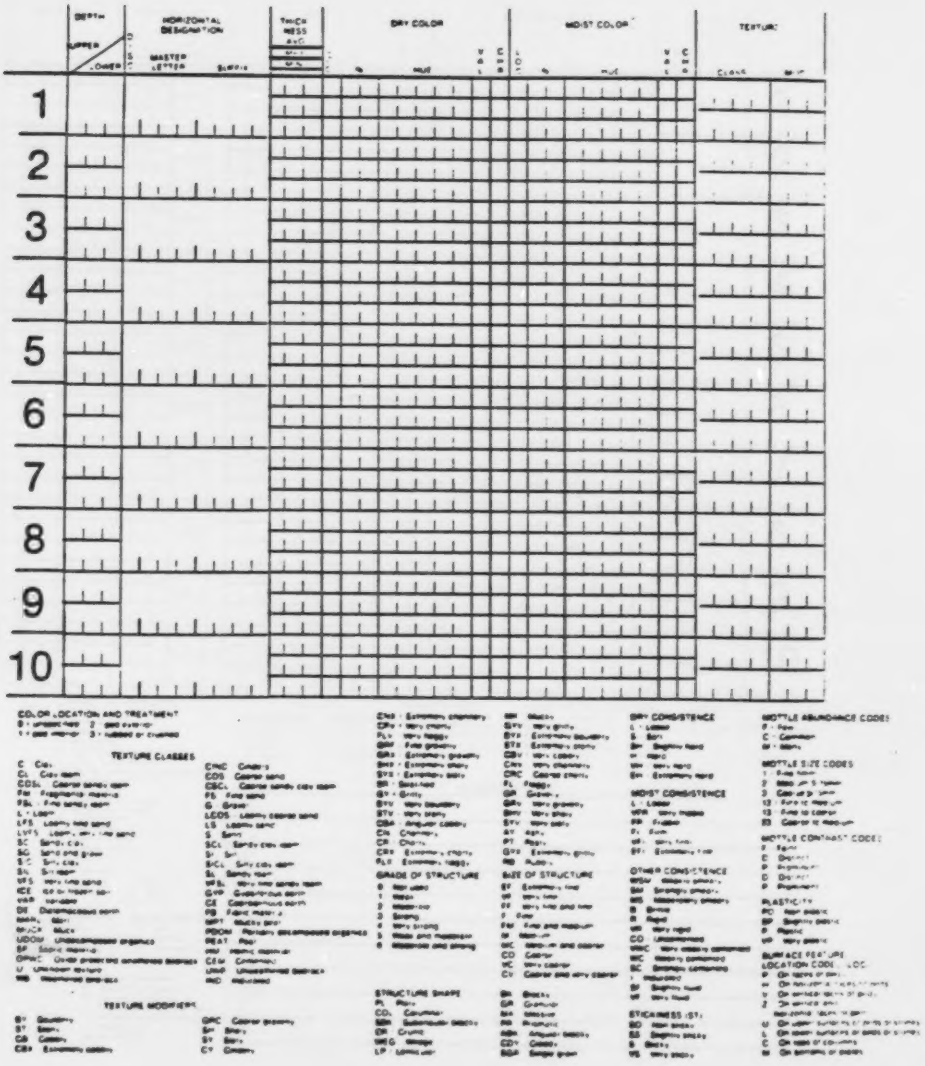
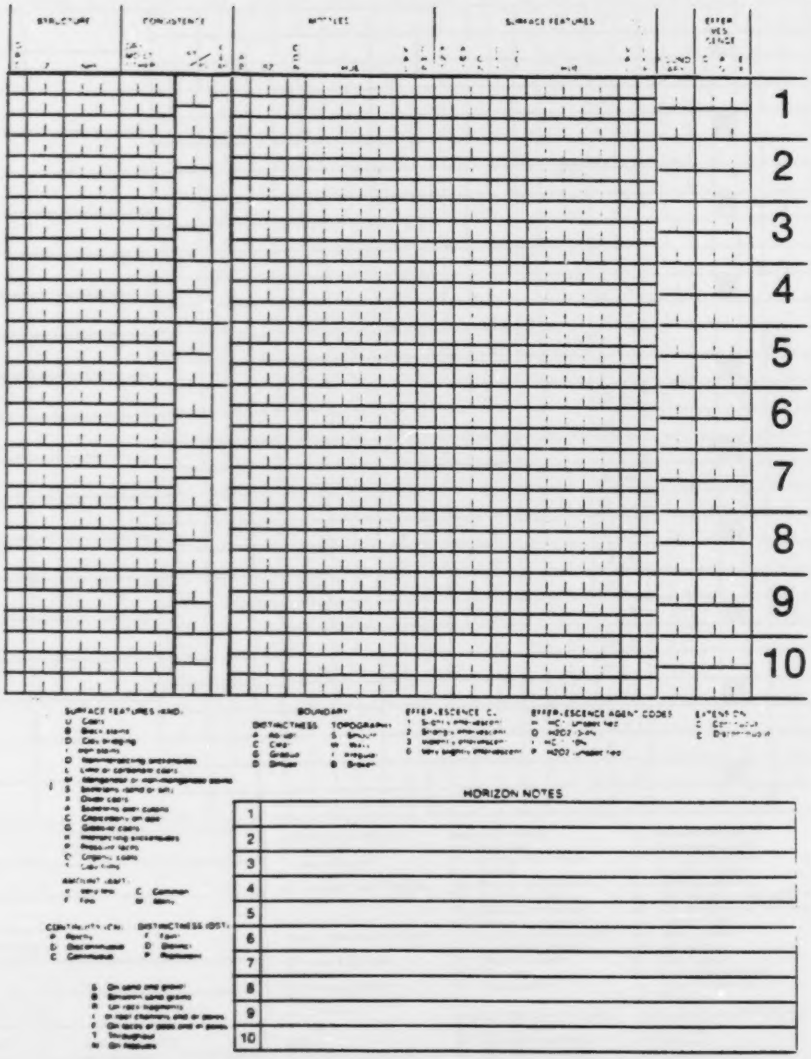
DRAFT

FORM SCS-SOI-232 (Continued)



DRAFT

FORM SCS-SOI-232 (Continued)



STRUCTURE

CONSISTENCE

MOTTLES

SURFACE FEATURES

EFFERVESCENCE

1

2

3

4

5

6

7

8

9

10

SURFACE FEATURES KIND

BOUNDARY

DISTINCTNESS

TOPOGRAPHY

EFFERVESCENCE CL

EFFERVESCENCE AGENT CODES

HORIZON NOTES

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

CONTINUITY (CN)

DISTINCTNESS (DST)

DRAFT

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FOR SCS-SOI-232 (Continued)

SAMPLES	CLODS	ROOTS			PORES			CONCENTRATIONS				FIELD MEASURED PROPERTIES		PERM WATER	ROCK FRAGMENTS			
		QT	SZ	LOC	SHP	QT	SZ	KND	QT	SHP	SZ	KND	AMOUNT		KND	%	SZ	
												P					1	1
														■			2	
																	3	
												P					1	2
														■			2	
																	3	
												P					1	3
														■			2	
																	3	
												P					1	4
												O A		■			2	
												O N					3	
												P					1	5
												O A		■			2	
												O N					3	
												P					1	6
												O A		■			2	
												O N					3	
												P					1	7
												O A		■			2	
												O N					3	
												P					1	8
												O A		■			2	
												O N					3	
												P					1	9
												O A		■			2	
												O N					3	
												P					1	10
												O A		■			2	
												O N					3	

LOG	
WEATHER	
SET I.D	
UNDERSTORY VEG	
SLIDES #s PED FACE	OVERSTORY
UNDERSTORY	LANDSCAPE

pH (Field Measured)
Methods - (KND)
pM - pH meter (1:1 H_2O)
pN - pH (.1M $CaCl_2$)
pH - Hellige-Truog
pL - Lamotte-Morgan
pB - Bromthymol blue

pC - Cresol red
pP - Phenol red
pT - Thymol blue
pS - Soiltex
pY - Ydrion
pG - Bromcresol green
pR - Chlorophenol red

LOCATION OF ROOTS
C = In cracks
P = Between peds
T = Throughout
M = In mat at top of horizon
S = Matted around stones

QUANTITY (QT)
(Roots Pores Concentrations)
VF = Very few
FF = Very few to few
F = Few
FC = Few to common
CM = Common to many
C = Common
M = Many

SIZE (SZ)
(Roots Pores Concentrations)
M = Micro
M1 = Micro and fine
V1 = Very fine
11 = Very fine and fine
1 = Fine
12 = Fine and medium
2 = Medium
23 = Medium and coarse
3 = Coarse
4 = Very coarse
5 = Extremely coarse
13 = Fine to coarse

SOIL MOISTURE CODES
D = Dry
M = Moist
V = Very moist
W = Wet

SHAPE OF PORES
IR = Interstitial
IT = Interstitial and tubular
TU = Tubular
TD = Discontinuous tubular
TS = Constricted tubular
VT = Vesicular and tubular
IE = Filled with coarse material
IF = Void between rock fragment
TC = Continuous tubular
TE = Dendritic tubular
VS = Vesicular
TP = Total porosity

KIND OF CONCENTRATIONS
B1 = Barite crystals
B2 = Soft masses of barite
K2 = Soft masses of carbonate
K3 = Carbonate concretions
K4 = Carbonate nodules
C1 = Calcite crystals
C2 = Soft masses of lime
C3 = Lime concretions
C4 = Lime nodules
T2 = Worm casts
T3 = Insect casts
T4 = Worm nodules
A2 = Clay bodies
D1 = Mica flakes
D2 = Soft dark masses
D3 = Dark concretions
D4 = Dark nodules
E3 = Gibbsite concretions
E4 = Gibbsite nodules
G1 = Gypsum crystals
G2 = Masses of gypsum

F1 = Plinthite segregations
F2 = Soft masses of iron
F3 = Iron concentrations
F4 = Ironstone nodules
M1 = Nonmagnetic shot
M2 = Soft masses of iron-manganese
M3 = Iron-manganese concentrations
M4 = Magnetic shot
H1 = Halite crystals
H2 = Salt masses
S1 = Opal crystals
S2 = Soft masses of silica
S3 = Silica concretions
S4 = Durinodes

SHAPE OF CONCENTRATIONS
C = Cylindrical
D = Dendritic
O = Rounded
P = Plate like
T = Threads
Z = Irregular

FIELD MEASURED PROPERTY KIND CODES
For organic materials
COLUMN 1
F = Fiber
H = Hemic
L = Limnic
S = Sapric
COLUMN 2
B = Unrubbed
W = Woody
S = Sphagnum
D = Diatomaceous earth
F = Ferrihumic
O = Other

Column 2 Cont
R = Rubbed
H = Herbaceous
C = Coprogenous earth
M = Marly
U = Humilluvic
L = Sulfidic

ROCK FRAGMENTS
1 = 20-76mm
2 = 76-250mm
3 = >250mm

For mineral materials
ON = Sand
OI = Silt
OA = Clay

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Left justify letters and right justify numbers. Use leading zeros to fill spaces where number entries are used. Enter zero as "0." All codes are on Form SCS-SOI-232, except for pedon classification and parent material codes, which are printed on another sheet. Metric units are specified for this project.

SITE DATA

Tier Number 1

Series Name

SOIL SERIES NAME

Column 16 on the first line will be used for a tax adjunct or variant of the soil series described; the letters T or V will be used respectively. If the soil described is listed other than at a series level, the code SND shall be used.

Sample Number

SAMPLE NUMBER			
St.	County	Unit	Sub

St. = State alpha code
County = 3-digit FIPS county code
Unit = 3-digit number identifying the pedon with a county
Sub = subunit alpha code if needed

DRAFT

MLRA

MLRA			Sub

Major Land Resource Areas

Latitude of Sample Site

LATITUDE						Dir
Deg		Min		Sec		

Longitude of Sample Site

LONGITUDE							Dir
Deg			Min		Sec		

Date

DATE					
Mo		Day		Yr	

Date = Date pedon was described
Mo = 2-digit code for month
Day = 2 digits, 0 used in left column if one
Yr = last 2 digits of the year

DRAFT

Tier Number 2

Slope Characteristics

SLOPE							
				MICRO			
%	SHP	GM	ASP	K	A	P	POS

% = Slope percent
SHP = Slope shape - The configuration of the slope
GM = Geomorphic position code - Specific part of a hillslope or mountain slope, grading from summit areas to lowlands
ASP = Slope aspect code - Direction slope is facing
MICRO = Microrelief codes
  K = Kind - Kind, amount and pattern of microrelief that includes polypedon described
  A = Amount in elevation code
  P = Pattern code - Pattern of the low parts of the microrelief
POS = Pedon position on slope code - Placement of the pedon site within the segment of the Geomorphic Component

Physiography

PHYS	
RG	LOC

RG = Regional - Landform extending for kilometers about the pedon site
LOC = Local - Landform in the immediate vicinity of the pedon site

Pedon Classification

PEDON CLASSIFICATION								
O	SO	GG	SG	PSC	MIN	RX	TMP	OTH

O = Order
SO = Suborder
GG = Great group
SG = Subgroup
PSC = Particle size class
MIN = Mineralogy
RX = Reaction
TMP = Temperature regime
OTH = Other code

Precipitation

PRECIP CM

Not coded by field crews

Water Table
(NSH p. 603-200)

WATER TABLE		
DEPTH CM	KD	MONTH

DEPTH = Depth to top of free water (NA used if no water table observed)
KD = Kind code
MONTH = Month described

Miscellaneous

LU	ST	PM	DR

LU = Land use code - Current use of the land at the pedon site
ST = Stoniness class - As defined in Soil Survey Manual (NSH p. 602-60)
PM = Permeability code - Code for the least permeable horizon excluding the surface horizon (NSH p. 603-19)
DR = Drainage class code - As indicated in the pedon description (SSM p. 4-32)

Tier Number 3

Elevation

ELEVATION METERS			
0	5	2	0

Parent Material (Glossary of Landform and Geologic Terms)

PARENT MATERIAL												BDRK
1			2			3			4			
W	M	ORIG	W	M	ORIG	W	M	ORIG	W	M	ORIG	
0			0			0			0			

W = Not coded by field crews, 0 in box
M = Mode of deposition code
ORIG = Origin of material code
BDRK = Bedrock fracturing

The Arabic numbers 1, 2, 3, and 4 are for separate types of material that may occur within the profile. They correspond to lithologic discontinuities.

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Temperatures

TEMPERATURE °C					
AVERAGE AIR			AVERAGE SOIL		
ANN	SUM	WINTER	ANN	SUM	WINTER

ANN = Annual
SUM = Summer
WINTER = Winter

Not coded by field crews

Moisture Regime
(MST RGE)
(Soil Taxonomy p. 51)

MST RGE

Weather station number

WEATHER STA NUMBER

Not coded by field crews

Tier Number 4

Control Section

CONTROL SECTION CM

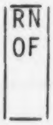
CONTROL SECTION = upper and lower limits of particle size control section (Soil Taxonomy p. 385)

Water erosion code (ERWA)

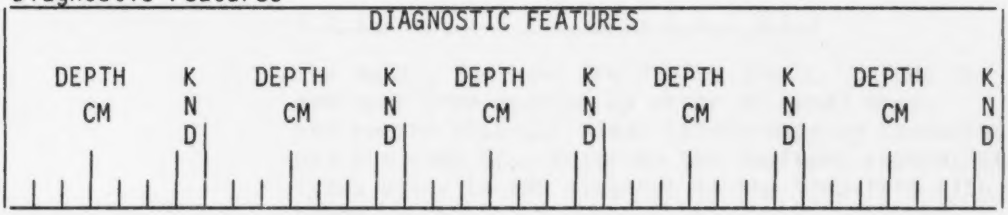
ER WA

Fill in for present conditions

Runoff code (RNOF)
(SSM p. 4-34)

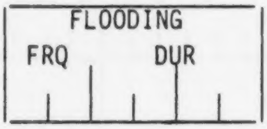


Diagnostic Features


DIAGNOSTIC FEATURES
DEPTH CM
KND
DEPTH CM
KND
DEPTH CM
KND
DEPTH CM
KND
DEPTH CM
KND

DEPTH = Upper and lower depths of feature
KND = Kind code
Coded in order of increased depth.

Flooding (NSH p. 603-40)


FLOODING
FRQ
DUR

FRQ = Frequency (times/yr)
DUR = Duration - months between which flooding occurs

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Tier Number 5

Vegetation-Scientific plant name symbol for dominant species (National Handbook of Plant Names)

VEGETATION SPECIES		
MAJOR	2nd	3rd

The major, 2nd, and 3rd fields should include the dominant tree species by order of basal area. For recent clearcut areas (since mapping conducted) use the code CC. Describe the dominant vegetation types prior to the clearcut in the free-form site notes.

Describers' Names and Crew I.D.

DESCRIBERS' NAMES	
	CREW I.D.

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Tier Number 6

Location Description

Spaces 1 - 6 = Watershed I.D.
7 = Dash
8 = Site Number
9 = Dash
10 - 12 = Sampling class code. If class has only 2 characters, add a zero (0) before the number i.e., S9 becomes S09.
13 = Dash
14 - 16 = Aspect - Determined by the face of the pit described in a perpendicular direction based on true north. If azimuth cannot readily be determined, as in Histosols, use N/A in this field. Use leading zeros.
17 = Degree symbol
18 to end = Location notes

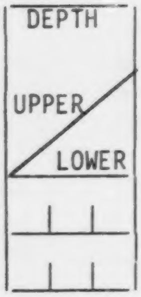
2A0	LOCATION DESCRIPTION
2607-1-SKU-106°	

FREE FORM SITE NOTES

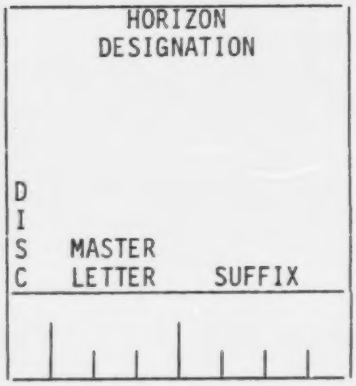
DRAFT

HORIZON DATA

Depth
(SSM p. 4-50)

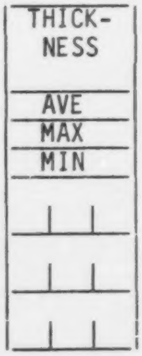

DEPTH
UPPER
LOWER

Horizon Designation
(SSM p. 4-39)


HORIZON DESIGNATION
D I S C
MASTER LETTER
SUFFIX

DISC = Discontinuity (Arabic number)
MASTER LETTER = Master horizon designation
SUFFIX = Subscript

Thickness (SSM p. 4-50)


THICK-NESS
AVE
MAX
MIN

AVE = Average thickness of horizon
MAX = Maximum thickness of horizon
MIN = Minimum thickness of horizon

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COLORS (Dry and Moist)

DRY COLOR

LOC	%	HUE	VAL	CHR

There is space for three matrix color entries. Enter the dominant color on upper line (SSM p. 4-62.)

LOC = Location code
% = Percent of matrix (leave blank if 100)
HUE = Hue (left justify. A decimal requires a space)
VAL = Value
CHR = Chroma

N Hues are coded as 0

MOIST COLOR

LOC	%	HUE	VAL	CHR

Texture

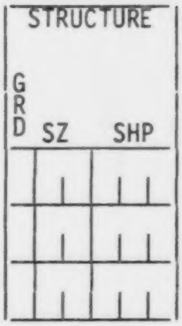
(SSM p. 4-52 and
NSH p. 603-198)

TEXTURE

CLASS	MOD

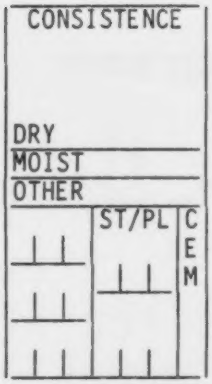
CLASS = Class code
MOD = Texture modifier

Structure


STRUCTURE
GRD
SZ
SHP

GRD = Grade code (SSM p. 4-72)
SZ = Size code (SSM p. 4-99)
SHP = Shape code (SSM p. 4-71)

Consistence
(SSM 4-81)


CONSISTENCE
DRY
MOIST
OTHER
ST/PL
CEM

DRY = Dry (1st line left side of field)
MOIST = Moist (2nd line left side of field)
OTHER = Other code (3rd line left side of field) (SSM p. 4-83)
ST = Stickiness (1st line middle of field)
PL = Plasticity (2nd line middle of field)
CEM = Cementation code (lower right of field) (SSM p. 4-79)

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Mottles
(SSM 4-66)

MOTTLES

AB	SZ	CON	HUE	VAL	CHR

AB = Abundance code
SZ = Size code
CON = Contrast code
HUE = Hue (left justify)
VAL = Value
CHR = Chroma

Surface features

SURFACE FEATURES

KND	AMT	CN	DST	LOC	HUE	VAL	CHR

KND = Kind code
AMT = Amount code
CN = Continuity
DST = Distinction code
LOC = Location code
HUE = Hue (left justify)
VAL = Value
CHR = Chroma

Boundary
(SSM p. 4-51)

Distinctness-left
Topography-right

```
 _________
|BOUN-    |
|DARY     |
|         |
|         |
|         |
|_________|
|         |
|____|____|
```

Effervescence
(SSM p. 4-91)

```
 ______________
|EFFERVES-     |
|  CENCE       |
|              |
|C    A     E  |
|L    G     X  |
|______________|
|              |
|____|____|____|
```

Not coded by field crews

CL = Class code
AG = Agent code
EX = Extent code

Roots
(SSM 4-85)

```
 ______________
|    ROOTS     |
|              |
|           L  |
|           O  |
|QT   SZ    C  |
|_____________ |
|    |    |    |
|_|__|_|__|____|
|    |    |    |
|_|__|_|__|____|
|    |    |    |
|_|__|_|__|____|
```

QT = Quantity code
SZ = Size code
LOC = Location code

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Pores
(SSM 4-84)

PORES

SHP	QT	SZ

SHP = Shape code
QT = Quantity code
SZ = Size code

Concentrations
(SSM 4-76)

CONCENTRATIONS

KND	QT	SHP	SZ

KND = Kind code
QT = Quantity code
SHP = Shape code
SZ = Size code

FIELD MEASURED PROPERTIES		PERM	SOIL
KND	AMOUNT		
P			
		###	###

KND = Kind code
pH = line one, all horizons
OA = % Clay, line two, horizon 4-10
ON = % Sand, line three, horizon 4-10
AMOUNT = Amount, no decimals
PERM = Permeability of horizon. Use same codes as permeability on page one. Upper line.
SOIL = Soil moisture code. Lower line.

Rock Fragments
(SSM 4-97)

ROCK FRAGMENTS		
KND	%	SZ
		1
		2
		3

KND = Kind code
% = Percent by volume
SZ = Size code
1) 20 - 76 mm
2) 76 - 250 mm
3) >250 mm

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Free
Form
Notes

Sample Codes	Clods

Sample Codes = Sample taken from particular horizon. Same sample code that appears on NADSS Label A.

Clods = Number of clods taken from particular horizon (if none, use 0)

LOG

1. Weather - Type of weather i.e., rainy, sunny, and avg. temp.
2. Set I.D. - Unique numbers assigned to crews for each day in the field.
3. Understory vegetation
4. Slides - Number of slides corresponding to specific picture from film roll

LOG

WEATHER

SET I.D.

UNDERSTORY VEGETATION -

SLIDE NO. pedon face overstory

understory landscape

2.0 SOIL DESCRIPTION CODES FOR FORM SCS-SOI-232

2.1 Slope Shape Codes

1 convex   2 plane   3 concave   4 undulating   5 complex

2.2 Geomorphic Position Codes

01 summit crested hills
02 shoulder crested hills
22 shoulder headslope
03 backslope crested hills
33 backslope sideslope
24 footslope headslope
44 footslope noseslope
25 toeslope headslope
04 footslope crested hills
11 summit interfluve
12 shoulder interfluve
42 shoulder noseslope
23 backslope headslope
43 backslope noseslope
34 footslope sideslope
05 toeslope crested hills
35 toeslope sideslope
00 not applicable
32 shoulder sideslope

2.3 Slope Aspect Codes

1 northeast   2 east   3 southeast   4 south
5 southwest   6 west   7 northwest   8 north

2.4 Microrelief (Micro) Codes

2.4.1 Kind (K) -

B = micro depression
C = tree-throw feature
F = frost polygon
G = gilgai
L = land leveled or smooth
M = mound
R = raised bog
T = terracettes
Z = other (specify in notes)

2.4.2 Variation in elevation (A) -

0 = minimal
1 = <20 cm
2 = 20-50 cm
4 = 50-100 cm

2.4.3 Pattern (P) -

0 = none
1 = linear
2 = closed depressions
3 = reticulate (net)

2.5 Pedon Position Codes

1 on the crest   2 on slope and crest   3 on upper third
4 on middle third   5 on lower third   6 on a slope
7 on a slope and depression   8 in a depression   9 in a drainageway

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2.6 Regional Landform Codes

A	coastal plains	B	intermountain basin
E	lake plains	F	river valley
G	glaciated uplands	H	glaciofluvial landform
I	bolson	K	karst
L	level or undulating uplands	M	mountains or deeply disected plateaus
N	high hills	P	piedmonts
R	hills	U	plateaus or tablelands
V	mountain valleys or canyons		

2.7 Local Landform Codes

A	fan	B	bog
C	cuesta or hogback	D	dome or volcanic cone
E	escarpment	F	broad plain
G	crater	H	abandoned channel
I	hillside or mountainside	J	moraine
K	kamefield	L	drumlin
M	mesa or butte	N	low sand ridge--non dunal
P	flood plain	Q	playa or alluvial flat
R	upland slope	S	sand dune or hill
T	terrace--stream or lake	U	terrace--outwash or marine
V	pediment	W	swamp or marsh
X	salt marsh	Y	barrier bar
Z	back barrier flat		

2.8 Great Group Codes

ALFISOLS

AAQAL	Albaqualf	AUDGL	Glossudalf
AAQNA	Natraqualf	AUDPA	Paleudalf
AAQPN	Plinthaqualf	AUSHA	Haplustalf
ABOCR	Cryoboralf	AUSPN	Plinthustalf
ABOGL	Glossoboralf	AXEFR	Fragixeral
AUDAG	Agrudalf	AXEPA	Palexeralf
AUDFS	Fraglossudalf	AAQFR	Fragiaqualf
AUDNA	Natrudalf	AAQOC	Ochraqualf
AUSDU	Durustalf	AAQUM	Umbraqualf
ASUPA	Paleustalf	ABOFR	Fragiboralf
AXEDU	Durixeralf	ABOPA	Paleboralf
AXENA	Natrixeralf	AUDFR	Fragiudalf
AXERH	Rhodoxeralf	AUDHA	Hapludalf
AAQDU	Duraqualf	AUDTR	Tropudalf
AAQGL	Glossaqualf	AUSNA	Natrustalf

DRAFT

AAQTR	Tropaqualf
ABOEU	Eutroboralf
ABONA	Natriboralf
AUDFE	Ferrudalf
AUSRH	Rhodustalf
AXEHA	Haploxeralf
AXEPN	Plinthoxeralf

ARIDISOLS

DARDU	Durargid
DARNT	Natrargid
DORCM	Camborthid
DORPA	Paleorthid
DARHA	Haplargid
DARPA	Paleargid
DORDU	Durorthid
DORSA	Salorthid
DARND	Nadurargid
DORCL	Calciorthid
DORGY	Gypsiorthid

ENTISOLS

EAQCR	Cryaquent
EAQHY	Hydraquent
EAQTR	Tropaquent
EFLTO	Torrifluvent
EFLUS	Ustifluent
EORTO	Torriorthent
EORUS	Ustorthent
EPSQU	Quartzipsamment
EPSUD	Udipsamment
EAQFL	Fluvaquent
EFLCR	Cryofluvent
EFLUD	Udifluvent
EORCR	Cryorthent
EAQPS	Psammaquent
EARAR	Arent
EFLTR	Tropofluvent
EFLXE	Xerofluvent
EORTR	Troporthent
EORXE	Xerorthent
EPSTO	Torripsamment
EPSUS	Ustipsamment
EAQHA	Haplaquent
EAQSU	Sulfaquent
EORUD	Udorthent
EPSCR	Cryopsamment
EPSTR	Tropopsamment
EPSXE	Xeropsamment

HISTOSOLS

HFIBO	Borofibrist
HFIME	Medifibrist
HFOBO	Borofolist
HHEBO	Borohemist
HHEME	Medihemist
HHETR	Tropohemist
HSAME	Medisaprist
HFICR	Cryofibrist
HFISP	Sphagnofibrist
HFOCR	Cryofolist
HHECR	Cryohemist
HHESI	Sulfihemist
HSABO	Borosaprist
HSATR	Troposaprist
HFILU	Luvifibrist
HFITR	Tropofibrist
HFOTR	Tropofolist
HHELU	Luvihemist
HHESO	Sulfohemist
HSACR	Cryosaprist

INCEPTISOLS

IANCR	Cryandept
IANEU	Eutrandept
IAQTR	Tropaquept
IOCDY	Dystrochrept

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IANVI Vitrandepth
IAQFR Fragiaquept
IAQHU Humaquept
IAQSU Sulfaquept
IOCDU Durochrept
IOCFR Fragiochrept
IPLPL Plaggept
ITRHU Humitropept
IUMCR Cryumbrept
IUMXE Xerumbrept
IANDU Durandept
IANHY Hydrandept
IAQAN Andaquept
IAQHL Halaquept
IAQPK Palacaquept

IOCUS Ustochrept
ITRDY Dystropept
ITRSO Sombritropept
IUMFR Fragiumbrept
IANDY Dystrandept
IANPK Placandept
IAQCR Cryaquept
IAQHP Haplaquept
IAQPN Plinthaquept
IOCCR Cryochrept
IOCEU Eutrochrept
IOCXE Xerochrept
ITREU Eutropept
ITRUS Ustropept
IUMHA Haplumbrept

MOLLISOLS

MALAR Argialboll
MAQCA Calciaquoll
MAQHA Haplaquoll
MBOCA Calciboroll
MBONA Natriboroll
MRERE Rendoll
MUDPA Paleudoll
MBOCR Cryoboroll
MBOPA Paleboroll
MUDAR Argiudoll
MUDVE Vermudoll
MUSDU Durustoll
MUSPA Paleustoll
MXECA Calcixeroll
MXENA Natrixeroll
MAQAR Argiaquoll
MAQDU Duraquoll

MUSCA Calciustoll
MUSNA Natrustoll
MXEAR Argixeroll
MXEHA Haploxeroll
MALNA Natralboll
MAQCR Cryaquoll
MAQNA Natraquoll
MBOAR Argiboroll
MBOHA Haploboroll
MBOVE Vermiboroll
MUDHA Hapludoll
MUSAR Argiustoll
MUSHA Haplustoll
MUSVE Vermustoll
MXEDU Durixeroll
MXEPA Palexeroll

OXISOLS

OAQGI Givvsiaquox
OAQUM Umbraquox
OHUHA Haplohumox
OOREU Eutrorthox
OORSO Sombriorthox
OUSAC Acrustox
OUSHA Haplustox
OAQOC Ochraquox

OORGI Gibbsiorthox
OORUM Umbriorthox
OUSEU Eutrustox
OUSSO Sombriustox
OAQPN Plinthaquox
OHUGI Gibbsihumox
OORAC Acrorthox
OORHA Haplorthox

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OHUAC Acrohumox
OHUSO Sombrihumox
OTOTO Torrox

SPODOSOLS

SAQCR Cryaquod
SAQHA Haplaquod
SAQTR Tropaquod
SHUFR Fragihumod
SHUTR Tropohumod
SORHA Haplorthod
SAQDU Duraquod
SAQPK Placaquod
SFEFE Ferrod
SHUHA Haplohumod
SORCR Cryorthod
SORPK Placorthod
SAQFR Fragiaquod
SAQSI Sideraquod
SHUCR Cryohumod
SHUPK Placohumod
SORFR Fragiorthod
SORTR Troporthod

ULTISOLS

UAQAL Albaquult
UAQPA Paleaquult
UAQUM Umbraquult
UHUPN Plinthohumult
UUDFR Fragiudult
UUDPN Plinthudult
UUSHA Haplustult
UUSRH Rhodustult
UAQFR Fragiaquult
UHUPA Palehumult
UHUTR Tropohumult
UUDPA Paleudult
UAQPN Plinthaquult
UHUHA Haplohumult
UHUSO Sombrihumult
UUDHA Hapludult
UUDRH Rhodudult
UUSPA Paleustult
UXEHA Haploxerult
UAQOC Ochraquult
UAQTR Tropaquult
UUDTR Tropudult
UUSPN Plinthustult
UXEPA Palexerult

VERTISOLS

VTOTO Torrert
VUSCH Chromustert
VXEPE Pelloxerert
VUDCH Chromudert
VUSPE Pellustert
VUDPE Pelludert
UXECH Chromxerert

2.9 Subgroup Codes

AA Typic
AB04 Abruptic aridic
AB10 Abruptic haplic
AB16 Abruptic xerollic
AE03 Aeric arenic
AE06 Aeric humic
AB Abruptic
AB08 Abruptic cryic
AB14 Abruptic ultic
AE Aeric
AE05 Aeric grossarenic
AE08 Aeric mollic

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AE09	Aeric tropic	AE10	Aeric umbric
AE12	Aeric xeric	AL	albaquic
AL02	Albaquultic	AL04	Albic
AL08	Albic glossic	AL10	Alfic
AL13	Alfic andeptic	AL12	Alfic arenic
AL16	Alfic lithic	AN24	Andaqueptic
AN01	Andeptic	AN11	Andeptic glossoboric
AN	Andic	AN06	Andic Dystric
AN22	Andic ustic	AN30	Anthropic
AQ	Aqualfic	AQ02	Aquentic
AQ04	Aqueptic	AQ06	Aquic
AQ08	Aquic arenic	AQ14	Aquic duric
AQ16	Aquic duriorthidic	AQ18	Aquic dystric
AQ24	Aquic haplic	AQ26	Aquic lithic
AQ31	Aquic psammentic	AQ34	Aquollic
AQ36	Aquultic	AR	Arenic
AR02	Arenic aridic	AR03	Arenic orthoxic
AR04	Arenic plinthaquic	AR06	Arenic plinthic
AR08	Arenic rhodic	AR10	Arenic ultic
AR14	Arenic umbric	AR16	Arenic ustalfic
AR18	Arenic ustollic	AR22	Argiaquic
AR24	Argiaquic xeric	AR26	Argic
AR28	Argic lithic	AR30	Argic pachic
AR32	Argic vertic	AR34	Aridic
AR36	Aridic calcic	AR42	Aridic duric
AR50	Aridic pachic	AR52	Aridic petrocalcic
AN03	Andaquic	BO	Boralfic
BO02	Borolfic lithic	BO04	Boroalfic udic
BO06	Borollic	BO08	Borollic glossic
BO10	Borollic lithic	BO12	Borollic vertic
CA	Calcic	CA04	Calcic pachic
CA06	Calciorthidic	CA10	Calcixerollic
CA20	Cambic	CH	Chromic
CH06	Chromudic	CR	Cryic
CR10	Cryic lithic	CR14	Cyric pachic
CU	Cumulic	CU02	Cumulic udic
CU04	Cumulic ultic		
DU	Durargidic	DU02	Duric
DU08	Durixerollic	DU10	Durixerollic lithic
DU11	Durochreptic	DU12	Durorthidic
DU14	Durorthidic xeric	DY02	Dystric
DY03	Dystric entic	DY04	Dystric Fluventic
DY06	Dystric lithic	DY08	Dystropeptic

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EN	Entic	EN02	Entic lithic
EN06	Entic ultic	EP	Epiaquic
EP10	Epiaquic orthoxic	EU	Eutric
EU02	Eutrochreptic	EU04	Eutropeptic
FE	Ferrudalfic	FI	Fibric
FI02	Fibric terric	FL02	Fluvaquentic
FL06	Fluventic	FL12	Fluventic umbric
FR10	Fragiaquic	FR18	Fragic
GL02	Glossaquic	GL04	Glossic
GL10	Glossic udic	GL12	Glossic ustollic
GL14	Glossoboralfic	GL16	Glossoboric
GR	Grossarenic	GR01	Grossarenic entic
GR04	Grossarenic plinthic		
HA01	Haplaquic	HA	Haplaquodic
HA02	Haplic	HA05	Haplohumic
HA07	Haploxerollic	HA09	Hapludic
HA12	Hapludollic	HA16	Haplustollic
HE	Hemic	HE02	Hemic terric
HI	Histic	HI02	Histic lithic
HI06	Histic pergelic	HU10	Humaqueptic
HU	Humic	HU02	Humic lithic
HU05	Humic pergelic	HU06	Humoxic
HY	Hydric	HY02	Hydric lithic
LE	Leptic	LI	Limnic
LI01	Lithic	LI04	Lithic mollic
LI06	Lithic ruptic-alfic	LI07	Lithic ruptic-argic
LI09	Lithic ruptic-entic	LI08	Lithic ruptic-entic-xerollic
LI13	Lithic ruptic-ultic	LI15	Lithic ruptic-xerochreptic
LI11	Lithic ruptic-xerorthentic	LI10	Lithic udic
LI12	Lithic ultic	LI14	Lithic umbric
LI16	Lithic ustic	LI18	Lithic ustollic
LI20	Lithic vertic	LI22	Lithic xeric
LI24	Lithic xerollic		
MO	Mollic	NA06	Natric
OC	Ochreptic	OR01	Orthic
OR	Orthidic	OR02	Orthoxic
OX	Oxic		
PA	Pachic	PA02	Pachic udic
PA04	Pachic ultic	PA06	Paleorthidic
PA08	Paleustollic	PA10	Palexerollic

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PA20	Paralithic vertic
PE	Pergelic
PE01	Pergelic ruptic-histic
PE02	Pergelic sideric
PE04	Petrocalcic
PE06	Petrocalcic ustalfic
PE08	Petrocalcic ustollic
PE14	Petrocalcic xerollic
PE16	Petroferric
PE20	Petrogypsic
PK	Placic
PK10	Plaggeptic
PK12	Plaggic
PL	Plinthaquic
PL04	Plinthic
PL06	Plinthudic
PS	Psammaquentic
PS02	Psammentic
QU	Quartzipsammentic
RE	Rendollic
RH	Rhodic
RU02	Ruptic-alfic
RU09	Ruptic-lithic
RU11	Ruptic-lithic-entic
RU15	Ruptic-lithic-xerochreptic
RU17	Ruptic-ultic
RU19	Ruptic-vertic
SA	Salorthidic
SA02	Sapric
SA04	Sapric terric
SI	Sideric
SO04	Sombrihumic
SP	Sphagnic
SP02	Sphagnic terric
SP04	Spodic
SU	Suflic
AA	Typic
TE	Terric
TH04	Thapto-histic
TH06	Thapto-histic tropic
TO	Torrertic
TO02	Torrifluventic
TO04	Torriorthentic
TO06	Torripsammentic
TO10	Torroxic
TR	Tropaquodic
TR02	Tropeptic
TR04	Tropic
UD01	Udalfic
UD	Udertic
UD02	Udic
UD03	Udollic
UD05	Udorthentic
UD10	Udoxic
UL	Ultic
UM	Umbreptic
UM02	Umbric
US	Ustalfic
US02	Ustertic
US04	Ustic
US06	Ustochreptic
US08	Ustollic
US12	Ustoxic
VE	Vermic
VE02	Vertic
XE	Xeralfic
XE02	Xerertic
XE04	Xeric
XE08	Xerollic

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2.10 Particle Size Codes

002 not used

005 ashy
008 ashy over loamy
019 ashy over medial
007 ashy over cindery
013 ashy over loamy-skeletal
009 ashy-skeletal

003 cindery
015 cindery over medial-skeletal
004 cindery over sandy or sandy-skeletal
114 clayey
116 clayey over fragmental
120 clayey over loamy-skeletal
118 clayey over sandy or sandy-skeletal
056 clayey-skeletal
006 cindery over loamy
122 clayey over fine-silty
124 clayey over loamy
058 clayey-skeletal over sandy

080 coarse-loamy
082 coarse-loamy over fragmental
084 coarse-loamy over sandy or sandy-skeletal
088 coarse-silty
090 coarse-silty over fragmental
092 coarse-silty over sandy or sandy-skeletal
126 fine
102 fine-loamy over clayey
100 fine-loamy over sandy or sandy-skeletal
106 fine-silty
108 fine-silty over fragmental
110 fine-silty over sandy or sandy-skeletal
086 coarse-loamy overy clayey
094 coarse-silty over clayey
096 fine-loamy
098 fine-loamy over fragmental
112 fine-silty over clayey

036 fragmental
072 loamy over sandy or sandy-skeletal
054 loamy-skeletal over clayey
052 loamy-skeletal over sand
010 medial
012 medial over cindery
016 medial over fragmental
020 medial over loamy-skeletal
022 medial over sandy or sandy-skeletal
024 medial over thixotropic
068 loamy
050 loamy-skeletal
051 loamy-skeletal over fragmental
014 medial over clayey
018 medial over loamy
011 medial-skeletal

062 sandy
066 sandy over clayey
044 sandy-skeletal
047 sandy-skeletal over clayey
063 sandy or sandy-skeletal
064 sandy over loamy
046 sandy-skeletal over loamy

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026 thixotropic
028 thixotropic over fragmental
034 thixotropic over loamy
032 thixotropic over loamy-skeletal
030 thixotropic over sandy or sandy-skeletal
027 thixotropic-skeletal
134 very fine

2.11 Mineralogy Codes

02 not used
04 calcareous
05 carbonatic
09 chloritic
07 clastic
08 coprogenous
10 diatomaceous
12 ferrihumic
14 ferritic
18 gibbsitic
20 glauconitic
22 gypsic
24 halloysitic
26 illitic
27 illitic (calcareous)
28 kaolinitic
30 marly
32 micaceous
34 mixed
35 mixed (calcareous)
37 montmorillonitic
38 montmorillonitic (calcareous)
40 oxidic
42 sepiolitic
44 serpentinitic
46 siliceous
50 vermiculitic

2.12 Reaction Codes

02 not used
04 acid
08 dysic
10 euic
12 nonacid
14 noncalcareous

2.13 Temperature Regime Codes

02 not used
04 frigid
06 hyperthermic
08 isofrigid
10 isohyperthermic
12 isomesic
14 isothermic
16 mesic
18 thermic

2.14 Other Family Codes

02 not used
04 coated
05 cracked
06 level
08 micro
12 ortstein
14 shallow
15 shallow and uncoated
17 shallow and coated
16 sloping
19 orstein shallow
20 uncoated

2.15 Kind of Water Table Codes

0 no water table observed
1 flooded
2 perched
3 apparent
4 ground water
5 ponded

2.16 Landuse Codes

A abandoned cropland (>3 yrs)
C cropland
E forest land grazed
F forest land not grazed
G pasture land and native pasture
H horticultural land

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I cropland irrigated
L waste disposal land
N barren land
P rangeland grazed
Q wetlands drained
R wetlands
S rangeland not grazed
T tundra
U urban and built-up land

2.17 Stoniness Class Codes

0 class 0
1 class 1
2 class 2
3 class 3
4 class 4
5 class 5

2.18 Permeability Codes

1 very slow
2 slow
3 moderately slow
4 moderate
5 moderately rapid
6 rapid
7 very rapid

2.19 Drainage Codes

1 very poorly drained
2 poorly drained
3 somewhat poorly drained
4 moderately well-drained
5 well-drained
6 somewhat excessively drained
7 excessively drained

2.20 Parent Material Mode of Deposition Codes

A alluvium
E eolian
H volcanic ash
W loess
S eolian-sand
D glacial drift
G glacial outwash
T glacial till
L lacustrine
M marine
O organic
V local colluvium
X residum
Y solifluctate
R solid rock
U unconsolidated sediments

2.21 Parent Material Origin Codes

Mixed Lithology

Y0 mixed
Y1 mixed-noncalcareous
Y2 mixed-calcareous
Y3 mixed-lithology, unspecified
Y4 mixed-igneous-metamorphic and sedimentary
Y5 mixed-igneous and metamorphic
Y6 mixed-igneous and sedimentary
Y7 mixed-metamorphic and sedimentary

Conglomerate

C0 conglomerate
C1 conglomerate-noncalcareous
C2 conglomerate-calcareous

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Igneous

10 igneous
11 igneous-coarse
12 igneous-basic
13 igneous-intermediate
14 igneous-granite
15 igneous-fine
16 igneous-basalt
17 igneous-andesite
18 igneous-acid
19 igneous-ultrabasic

Metamorphic

M0 metamorphic
M1 gneiss
M2 metamorphic-acidic
M3 metamorphic-basic
M4 serpentine
M5 schist and thyllite
M6 metamorphic-acidic
M7 metamorphic-basic
M8 slate
M9 quartzite

Sedimentary

S0 sedimentary
S1 marl
S2 glauconite

Interbedded Sedimentary

B0 interbedded sedimentary
B1 limestone-sandstone-shale
B2 limestone-sandstone
B3 limestone-shale
B4 limestone-siltstone
B5 sandstone-shale
B6 sandstone-siltstone
B7 shale-siltstone

Sandstone

A0 sandstone
A1 sandstone-noncalcareous
A2 arkosic-sandstone
A3 other sandstone
A4 sandstone-calcareous

Shale

H0 shale
H1 shale-noncalcareous
H2 shale-calcareous

Siltstone

T0 siltstone
T1 siltstone-noncalcareous
T2 siltstone-calcareous

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Limestone

L0 limestone
L1 chalk
L2 marble
L3 dolomite
L4 limestone-phosphatic
L5 limestone-arenaceous
L6 limestone-argillaceous
L7 limestone-cherty

Pyroclastic

P0 pyroclastic
P1 tuff
P2 tuff-acidic
P3 tuff-basic
P4 volcanic breccia
P5 breccia-acidic
P6 breccia-basic
P7 tuff-breccia
P8 aa
P9 pahoehoe

Ejecta Material

E0 ejecta-ash
E2 basic-ash
E1 acidic-ash
E4 andesitic-ash
E3 basaltic-ash
E6 pumice
E5 cinders
E8 volcanic bombs
E7 scoria

Organic Materials

K0 organic
K1 mossy material
K2 herbaceous material
K3 woody material
K4 wood fragments
K5 logs and stumps
K6 charcoal
K7 coal
K9 other organics

2.22 Bedrock Fracturing

1. 10 cm between fractures
2. 10 to 45 cm between fractures
3. 45 cm to 1 m between fractures
4. 1 to 2 m between fractures
5. 2 m between fractures

2.23 Moisture Regime Codes

AR aridic moisture regime
UD udic moisture regime
US ustic moisture regime
TO torric moisture regime
AQ aquic moisture regime
PU perudic moisture regime
XE xeric moisture regime

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2.24 Erosion Codes

0 none
1 slight
2 moderate
3 severe

2.25 Runoff Codes

1 none
2 ponded
3 very slow
4 slow
5 moderate
6 rapid
7 very rapid

2.26 Diagnostic Feature Codes

Epipedon

A anthropic
H histic
M mollic
O ochric
P plaggen
U umbric

Horizons

Q albic
R argic
T argillic
C calcic
B cambic
G gypsic
N natric
X oxic
E petrocalcic
J petrogypsic
K placic
Y salic
I sombric
S spodic
V sulfuric

Properties

D durinodes
Z duripan
L lithic contact
W paralithic contact
F fragipan

2.27 Horizon Codes

Color Location Codes

0 unspecified
1 ped interior
2 ped exterior
3 rubbed or crushed

2.28 Texture Classes

C	clay	CIND	cinders
CL	clay loam	COS	coarse sand
COSL	coarse sandy loam	CSCL	coarse sandy clay loam
FM	fragmental material	FS	fine sand
FSL	fine sandy loam	G	gravel
L	loam	LCOS	loamy coarse sand
LFS	loamy fine sand	LS	loamy sand
LVFS	loamy very fine sand	S	sand
SC	sandy clay	SCL	sandy clay loam
SG	sand and gravel	SI	silt

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SIC	silty clay	SICL	silty clay loam
SIL	silt loam	SL	sandy loam
VFS	very fine sand	VFSL	very fine sandy loam
ICE	ice or frozen soil	GYP	gypsiferous earth
VAR	variable	CE	coprogenous earth
DE	diatomaceous earth	FB	fibric material
MARL	marl	MPT	mucky peat
MUCK	muck	PDOM	partially decomposed organics
UDOM	undecomposed organics	PEAT	peat
SP	sapric material	HM	hemic material
OPWD	oxide protected weathered bedrock	UWB	unweathered bedrock
U	unknown texture	IND	indurated
WB	weathered bedrock	CEM	cemented

2.29 Texture Modifiers

BY	bouldery	BYV	very bouldery	BYX	extremely bouldery
ST	stony	STV	very stony	STX	extremely stony
CB	cobbly	CBA	angular cobbly	CBV	very cobbly
CBX	extremely cobbly	CN	channery	CNV	very channery
CNX	extremely channery	CR	cherty	CRC	coarse cherty
CRV	very cherty	CRX	extremely cherty	FL	flaggy
FLV	very flaggy	FLX	extremely flaggy	GR	gravelly
GRF	fine gravelly	GRC	coarse gravelly	GRV	very gravelly
GRX	extremely gravelly	SH	shaly	SHV	very shaly
SHX	extremely shaly	SY	slaty	SYV	very slaty
SYX	extremely slaty	CY	cindery	AY	ashy
SR	stratified	MK	mucky	PT	peaty
GY	gritty	GYV	very gritty	GYX	extremely gritty
RB	rubbly				

2.30 Grade of Structure

0	not used	1	weak	2	moderate
3	strong	4	very strong	5	weak and moderate
6	moderate and strong				

2.31 Size of Structure

EF	extremely fine	VF	very fine	FF	very fine and fine
F	fine	FM	fine and medium	M	medium
MC	medium and coarse	CO	coarse	VC	very coarse
CV	coarse and very coarse				

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2.32 Structure Shape

PL	platy	LP	lenticular	PR	prismatic
COL	columnar	BK	blocky	ABK	angular blocky
SBK	subangular blocky	GR	granular	CDY	cloddy
CR	crumb	MA	massive	SGR	single grain
WEG	wedge				

2.33 Dry Consistence

L	loose	S	soft	SH	slightly hard
H	hard	VH	very hard	EH	extremely hard

2.34 Moist Consistence

L	loose	VFR	very friable	FR	friable	FI	firm
VFI	very firm	EFI	extremely firm				

2.35 Other Consistence

WSM	weakly smeary	SM	strongly smeary	MS	moderately smeary
B	brittle	R	rigid	VR	very rigid
CO	uncemented	VWC	very weakly cemented	WC	weakly cemented
SC	strongly cemented	I	indurated	SF	Slightly fluid
VF	very fluid				

2.36 Stickiness

SO	nonsticky	SS	slightly sticky	S	sticky	VS	very sticky

2.37 Plasticity

PO	nonplastic	SP	slightly plastic	P	plastic
VP	very plastic				

2.38 Cementation Agent

H	humus	I	iron	L	lime	S	silica
X	lime and silica						

2.39 Mottle Abundance Codes

F	few	C	common	M	many

2.40 Mottle Size Codes

1	fine (5 mm)	2	medium (5 to 15 mm)	3	coarse (>15 mm)
12	fine to medium	13	fine to coarse	23	medium to coarse

2.41 Mottle Contrast Code

F faint
D distinct
P prominent

2.42 Surface Features

U coats
B black stains
D clay bridging
I iron stains
Q nonintersecting slickensides
L lime or carbonate coats
M manganese or iron-manganese stains
S skeletans (sand or silt)
X oxide coats

A skeletans over cutans
C chalcedony on opal
G gibbsite coats
K intersecting slickensides
P pressure faces

O organic coats
T clay films

2.43 Surface Feature Amount Codes

V very few
F few
C common
M many

2.44 Surface Feature Continuity Codes

P patchy
D discontinuous
C continuous

2.45 Surface Feature Distinctness Codes

F faint
D distinct
P prominent

2.46 Location of Surface Features

P on faces of peds
H on horizontal faces of peds
V on vertical faces of peds
Z on vertical and horizontal faces of peds
U on upper surfaces of peds or stones
L on lower surfaces of peds or stones
C on tops of columns
S on sand and gravel
R on rock fragments
F on faces of peds and in pores
N on nodules

M on bottoms of plates
B between sand grains
I in root channels and/or pores
T throughout

2.47 Boundary

A abrupt
C clear
G gradual
D diffuse

2.48 Topography

S smooth
W wavy
I irregular
B broken

2.49 Effervescence

1 slightly effervescent
2 stongly effervescent
3 violently effervescent
0 very slightly effervescent

2.50 Effervescence Agent Codes

H HCl (unspecified)
I HCl (10%)
P H_2O_2 (unspecified)
Q H_2O_2 (3 to 4%)

2.51 Field Measured Property Kind Codes

2.51.1 For Organic Materials -

Column 1	Column 2	
F fiber	B unrubbed	R rubbed
H hemic	W woody	H herbacious
L limnic	S sphagnum	C coprogenous earth
S sapric	D diatomaceous earth	M marly
	F ferrihumic	U humilluvic
	O other	L sulfidic

2.51.2 For Mineral Materials -

ON sand
OI silt
OA clay

2.51.3 pH -

pM pH meter (1:1 H_2O)
pL Lamotte-Morgan
pP Phenol red
pY Ydrion
pN pH (0.1 M $CaCl_2$)
pB Bromthymol blue
pT Thymol blue
pG Bromcresol green
pH Hellige-Truog
pC Cresol red
pS soiltex
pR Chlorophenol red

2.52 Soil Moisture Codes

D dry
M moist
V very moist
W wet

2.53 Quantity (Roots, Pores, Concretions)

VF very few
CM common to many
FF very few to few
C common
F few
M many
FC few to common

2.54 Size (Roots, Pores, Concretions)

M micro
11 very fine and fine
2 medium
4 very coarse
M1 micro and fine
1 fine
23 medium and coarse
5 extremely coarse
V1 very fine
12 fine and medium
3 coarse
13 fine to coarse

2.55 Location of Roots

C in cracks
P between peds
T throughout
M in mat at top of horizon
S matted around stones

2.56 Shape of Pores

IR interstitial
IT interstitial and tubular
TU tubular
TD discontinuous tubular
TS constricted tubular
VT vesicular and tubular
IE filled with coarse material
IF void between rock fragment
TC continuous tubular
TE dendritic tubular
VS vesicular
TP total porosity

2.57 Kind of Concentrations

B1 barite crystals
K2 soft masses of carbonate
K4 carbonate nodules
C2 soft masses of lime
C4 lime nodules
T3 insect casts
A2 clay bodies
D2 soft dark masses
D4 dark nodules
E4 gibbsite nodules
G2 masses of gypsum
F2 soft masses of iron
F4 ironstone nodules
M2 soft masses of iron-manganese
M4 magnetic shot
H2 salt masses
S2 soft masses of silica
S4 durinodes
B2 soft masses of barite
K3 carbonate concretions
C1 calcite crystals
C3 lime concretions
T2 worm casts
T4 worm nodules
D1 mica flakes
D3 dark concretions
E3 gibbsite concretions
G1 gypsum crystals
F1 plinthite segregations
F3 iron concretions
M1 nonmagnetic shot
M3 iron-manganese concretions
H1 halite crystals
S1 opal crystals
S3 silica concretions

2.58 Shape of Concentrations

C cylindrical
T threads
d dendritic
Z irregular
O rounded
P plate like

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2.59 Rock Fragment Kind Codes

Y mixed lithology
S sedimentary rocks
A sandstone

H shale
K organic fragments
O oxide-protected rock

I igneous rocks
B mixed sedimentary rocks
T siltstone

P pyroclastic rocks
F ironstone

M metamorphic rocks

L limestone

E ejecta
R saprolite

2.60 Rock Fragment Size Codes

1. 20 to 76 mm
2. 76 to 250 mm
3. >250 mm

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APPENDIX D

PREPARATION LABORATORY FORMS

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NATIONAL ACID DEPOSITION SOIL SURVEY (NADSS) FORM 101

Batch ID ______________________
Crew ID ______________________
Batch Sent To ______________________
Date Shipped
DATE RECEIVED BY DATA MGT _ _ _ _ _ _ _
No of Samples _ _

Set ID	_ _ _ _	_ _ _ _	_ _ _ _
Date Sampled	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _
Date Received	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _
Date Prep Completed	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _
Set ID	_ _ _ _	_ _ _ _	_ _ _ _
Date Sampled	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _
Date Received	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _
Date Prep Completed	_ _ _ _ _ _ _	_ _ _ _ _ _ _	_ _ _ _ _ _ _

SAMPLE NO	SITE ID	SAMPLE CODE	SET ID	Rock FRAGMENTS wt %	AIR DRIED MOISTURE wt %	Soil Type M = MIN O = ORG	INORG CARBON (IC) Y = YES N = NO	BULK DENSITY g/cc
01								
02								
03								
04								
05								
06								
07								
08								
09								
10								
11								
12								
13								
14								
15								
16								
17								
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40								
41								
42								

Signature of Preparation Laboratory Manager ______________________
Comments

NATIONAL ACID DEPOSITION SOIL SURVEY (NADSS)
SHIPPING FORM 102

DATE RECEIVED
BY DATA MGT D D M M M Y Y

Prep Lab ID ____________________ Date Received D D M M M Y Y _ _ _ _ _ _ _
Batch ID ____________________ Date Shipped _ _ _ _ _ _ _
Analytical Lab ID ____________________

SAMPLE NO	Sample (Identify By Check)		Soil Type (Identify By Check)		Inorganic Carbon Y = Yes N = No	Rock Fragments Shipped? Check If Yes
	Shipped	Received	Organic	Mineral		
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						
11						
12						
13						
14						
15						
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38						
39						
40						
41						
42						

Signature of Preparation Laboratory Manager ____________________
Comments

WHITE - SMO CANARY - ANALYTICAL WITH COPY TO SMO PINK - ANALYTICAL WITH COPY TO [illegible] GOLD - ANALYTICAL LAB [illegible]

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APPENDIX E

LIST OF THE NORTHEAST SOILS BY SAMPLING CLASS

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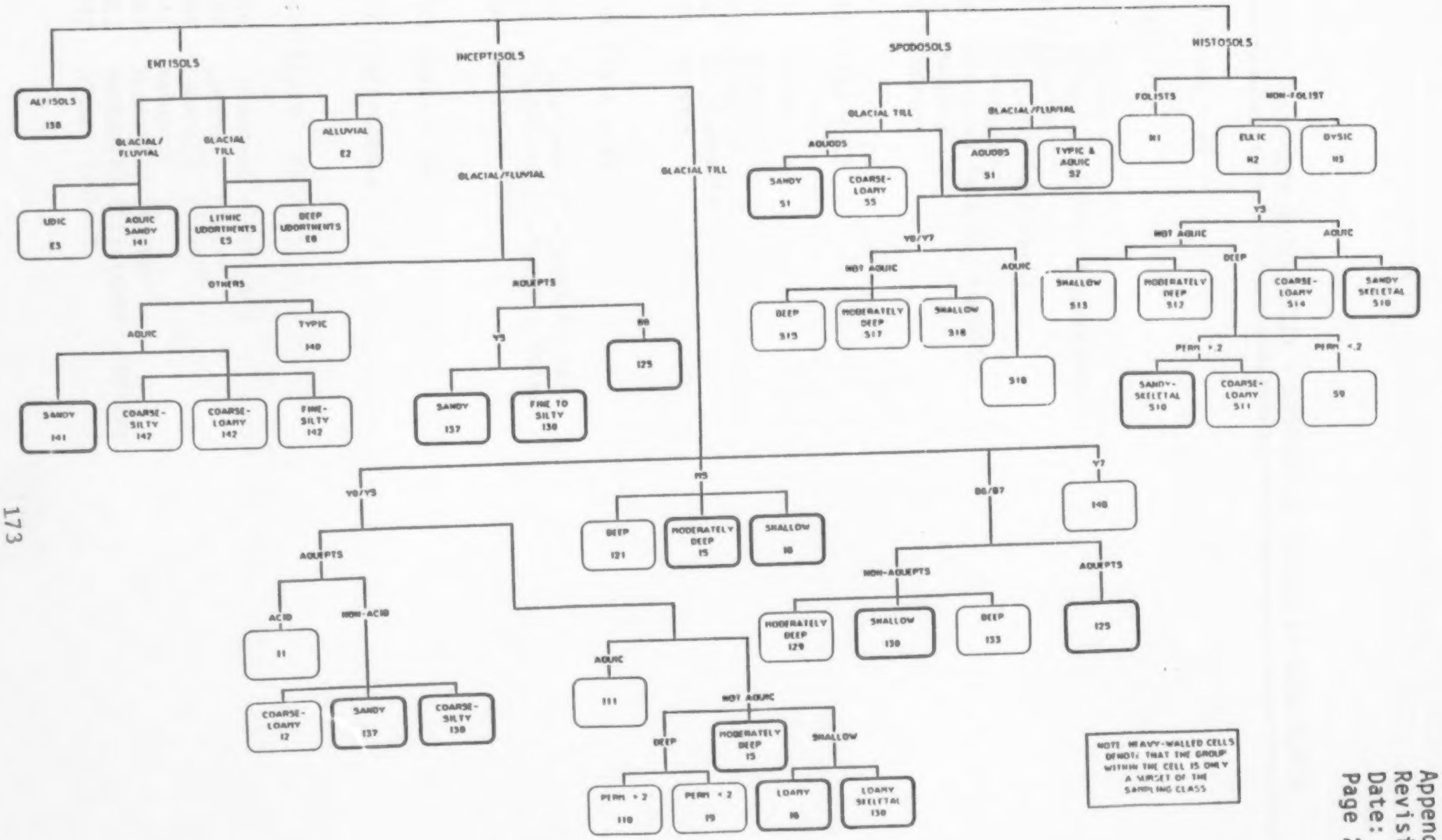
SOIL ORDERS


ALFISOLS
138
ENTISOLS
GLACIAL/ FLUVIAL
UDIC
E3
AQUIC SANDY
141
GLACIAL TILL
LITHIC UDORTHENTS
E5
DEEP UDORTHENTS
E8
ALLUVIAL
E2
INCEPTISOLS
GLACIAL/FLUVIAL
OTHERS
AQUIC
SANDY
141
COARSE-SILTY
142
COARSE-LOAMY
142
FINE-SILTY
142
TYPIC
140
AQUEPTS
Y5
SANDY
137
FINE TO SILTY
130
B8
125
GLACIAL TILL
Y0/Y5
AQUEPTS
ACID
I1
NON-ACID
COARSE-LOAMY
I2
SANDY
137
COARSE-SILTY
130
AQUIC
111
NOT AQUIC
DEEP
PERM > 2
110
PERM < 2
19
MODERATELY DEEP
15
SHALLOW
LOAMY
18
LOAMY SKELETAL
130
M5
DEEP
121
MODERATELY DEEP
15
SHALLOW
18
B6/B7
NON-AQUEPTS
MODERATELY DEEP
129
SHALLOW
130
DEEP
133
AQUEPTS
125
Y7
140
SPODOSOLS
GLACIAL TILL
AQUODS
SANDY
S1
COARSE-LOAMY
S5
Y0/Y7
NOT AQUIC
DEEP
S15
MODERATELY DEEP
S17
SHALLOW
S18
AQUIC
S18
Y5
NOT AQUIC
SHALLOW
S13
MODERATELY DEEP
S12
DEEP
PERM > 2
SANDY-SKELETAL
S10
COARSE-LOAMY
S11
PERM < 2
S9
AQUIC
COARSE-LOAMY
S14
SANDY SKELETAL
S10
GLACIAL/FLUVIAL
AQUODS
S1
TYPIC & AQUIC
S2
HISTOSOLS
FOLISTS
H1
NON-FOLIST
EULIC
H2
DYSIC
H3

NOTE: HEAVY-WALLED CELLS DENOTE THAT THE GROUP WITHIN THE CELL IS ONLY A SUBSET OF THE SAMPLING CLASS

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EPA SOIL SURVEY - LISTING OF SERIES BY SOIL CLASS

Soil Class - E2

Series List

18	Basher
30	Borosaprists(A)-'Fluvaquents'
44	Charles
72	Fluv-udifluvaquents
71	Fluvaquents
178	Mediasaprists(A)-'Aquents'
118	Medomak
175	Rumney

Soil Class - E3

42	Carver
89	Hinckley
156	Plymouth
504	Udipsamments
234	Windsor

Soil Class - E5

263	'Udorthents' -Lyman-Ricker
705	'Udorthents' -Taconic-Rock
181	Schoodic-Rock

Soil Class - E6

217	Udorthents

Soil Class - H1

356	'Mahoosuc'-Enchanted
254	Lyman(C)-'Ricker'
254	Lyman(E)-'Ricker'
241	Mahoosuc
352	Monson(C)-'Ricker'
353	Monson(E)-Elliotsvill-'Ricker'
242	Ricker-Rockout

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - H1 (Continued)

Series List

176	Saddleback(E)-'Ricker'-Rockout
248	Tunbridge(C)-Borosap-'Ricker'
263	Udorthents(C)-Lyman-'Ricker'
263	Udorthents(E)-Lyman-'Ricker'
263	Udorthents(F)-Lyman-'Ricker'

Soil Class - H2

178	'Medisaprist'-Aquents
2	Adrian
258	Carbondale
41	Carlisle
253	Cathro
144	Palms
168	Rifle

Soil Class - H3

30	'Borosaprists'-Fluvaquents
79	'Greenwood'-Ossipee
243	Beseman
53	Chocorua
61	Dawson
506	Freetown
79	Greenwood(A)-'Ossipee'
103	Loxley
104	Lupton
188	Sebago
510	Swansea
248	Tunbidge(C)-'Borosap'-Ricker
226	Waskish

Soil Class - I1

767	'Haplaquept'-Humaquept
767	Haplaquepts(A)-'Humaquepts'

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - I1 (Continued)

Series List

98	Leicester
107	Lyme
136	Neversink
211	Tughill

Soil Class - I2

252	Brayton
259	Insula(C)-Rockout-'Massena'
150	Pillsbury
167	Ridgebury

Soil Class - I5

47	'Chatfield'-Hollis-Charlton
48	'Chatfield'-Hollis-Rockout
108	'Macomber'-Taconic
46	Charlton(C)-'Chatfield
704	Taconic(E)-'Macomber'-Rockout

Soil Class - I6

250	'Hollis'-Rockout
704	'Taconic'-Macomber-Rockout
47	Chatfield(C)-'Hollis'-Charlton
48	Chatfield(C)-'Hollis'-Rockout
514	Hollis-Rockout
108	Macomber(C)-'Taconic'
251	Rockout-Hollis
705	Udorthents(C)-'Taconic'Rockout
705	Udorthents(E)-'Taconic'Rockout
705	Udorthents(F)-'Taconic'Rockout

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - I9

Series List

515	Broadbrook
127	Montauk
145	Paxton

Soil Class - I10

Series List

46	'Charlton'-Chatfield
38	Canton
45	Charlton
47	Chatfield(C)-Hollis-'Charlton'
76	Gloucester
505	Narragansett

Soil Class - I11

516	Rainbow
185	Scituate
199	Sutton
236	Woodbridge

Soil Class - I21

701	Dummerston
702	Fullam
703	Lanesboro

Soil Class - I25

52	Chippewa
129	Morris
138	Norwich
165	Rexford
186	Scriba
257	Tuller
224	Volusia

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - I29

Series List

246	'Manlius'-Nassau
142	'Oquaga'-Arnot
101	Lordstown
110	Manlius
141	Oquaga

Soil Class - 130

12	'Arnot'-Rockout
261	'Insula'-Rockout
260	'Insula'-Rockout-Burnham
259	'Insula'-Rockout-Massena
142	Oquaga(C)-'Arnot'
11	Arnot
246	Manlius(B)-'Arnot'
142	Oquaga(B)-'Arnot'
142	Oquaga(D)-'Arnot'

Soil Class - I33

97	'Lackawanna'-Swartswood
96	Lackawanna
97	Lackawanna(E)-'Swartswood'
114	Mardin
202	Swartswood
229	Wellsboro
239	Wurtsboro

Soil Class - I-37

128	Moosilauke
511	Scarboro
187	Searsport

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - I38

Series List

28	Biddeford
262	Muskellunge
146	Peacham
163	Raynham
173	Roundabout
180	Scantic
201	Swanville
512	Whitman

Soil Class - I40

4	Agawam
31	Bracefille
507	Haven
120	Merrimac
170	Riverhead
240	Wyoming

Soil Class - I41

62	Deerfield
503	Sudbury

Soil Class - I42

517	Belgrade
29	Boothbay
37	Buxton
183	Scio
508	Tisbury

Soil Class - I46

36	Burnham
260	Insula(E)-Rock-'Burnham'
123	Monarda

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - S01

Series List

131	Naskeag
135	Naumberg
134	Naumburg
151	Pipestone

Soil Class - S02

7	'Allagash'-Adams
351	'Masardis'-Rockout
1	Adams
6	Allagash
7	Allagash(C)-'Adams'
54	Colton
57	Croghan
64	Duane
116	Masardis
190	Sheepscot

Soil Class - S05

3	Aeric Haplaquod
244	Typic Haplaquod

Soil Class - S09

21	'Becket'-Lyman
21	'Becket'-Lyman-Tunbridge
161	'Potsdam'-Tunbridge
20	Becket
115	Marlow
160	Potsdam

Soil Class - S10

88	'Hermon'-Lyman
87	Hermon
227	Waumbek

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - S11

Series List

23	'Berkshire'-Lyman
22	Berkshire
59	Danforth
122	Monadnock
214	Tunbridge(C)-'Berkshire'
214	Tunbridge(E)-'Berkshire'-Lyman

Soil Class - S12

162	'Rawsonville'-Hogback
214	'Tunbridge'-Berkshire
214	'Tunbridge'-Berkshire-Lyman
248	'Tunbridge'-Borosaprists-Ricke
215	'Tunbridge-Lyman
21	Becket(E)-Lyman-'Tunbridge
90	Hogback(C)-'Rawsonville'
161	Potsdam(C)-'Tunbridge'
161	Potsdam(E)-'Tunbridge'
213	Tunbridge

Soil Class - S13

90	'Hogback'-Rawsonville
254	'Lyman'-Ricker
106	'Lyman'-Rockout
176	'Saddleback'-Ricker-Rockout
21	Becket(C)-'Lyman'
21	Becket(E)-'Lyman'-Tunbridge
21	Becket(F)-'Lyman'
23	Berkshire(C)-'Lyman'
88	Hermon(C)-'Lyman'
88	Hermon(E)-'Lyman'
105	Lyman
162	Rawsonville(C)-'Hogback'
162	Rawsonville(D)-'Hogback'
172	Rockout-'Lyman'
215	Tunbridge(C)-'Lyman'
215	Tunbridge(E)-'Lyman'

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - S13 (continued)

Series List

215	Tunbridge(E)-Berkshire-'Lyman'
215	Tunbridge(F)-'Lyman'
263	Udorthents(C)-'Lyman'-Ricker
263	Udorthents(E)-'Lyman'-Ricker
263	Udorthents(F)-'Lyman'-Ricker

Soil Class - S14

56	Crary
148	Peru
192	Skerry
196	Sunapee
238	Worden

Soil Class - S15

15	Bangor
51	Chesuncook
355	Enchanted
356	Mahoosuc(E)-'Enchanted'
356	Mahoosuc(F)-'Enchanted'

Soil Class - S16

63	Dixmont
357	Howland
137	Nicholville
354	Surplus
204	Telos

Soil Class - S17

67	Elliottsville
353	Monson(E)-'Elliotsvill'-Ricker
358	Thorndike(E)-'Winnecook'
253	Winnecook

(continued)

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EPA Soil Survey - Listing of Series by Soil Class (Continued)

Soil Class - S18

Series List

353	'Monson'-Elliotsville-Ricker
352	'Monson'-Ricker
126	'Monson'-Rockout
206	'Thorndike'-Rockout
358	'Thorndike'-Winnecook
125	Monson
205	Thorndike

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APPENDIX F

LIST OF THE SOUTHERN BLUE RIDGE SOILS BY SAMPLING CLASS

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******************** GROUP      1 ... ACC **************
 191 BRADDOCK              AC Clayey     Typic  Hapludults     A    368.7
 192 BRADDOCK              AC Clayey     Typic  Hapludults     A     97.2
 176 BRADDOCK              AC Clayey     Typic  Hapludults     A    247.9
 207 CLIFTON               AC Clayey     Typic  Hapludults     X    704.7
 208 CLIFTON               AC Clayey     Typic  Hapludults     X     79.8
 382 CLIFTON               AC Clayey     Typic  Hapludults     X     57.2
 232 HAYESUILLE            AC Clayey     Typic  Hapludults     X    381.0
 233 HAYESUILLE            AC Clayey     Typic  Hapludults     X   1189.5
 234 HAYESUILLE            AC Clayey     Typic  Hapludults     X   1159.5
 354 HAYSEUILLE            AC Clayey     Typic  Hapludult      X      4.4
 356 HAYSEUILLE            AC Clayey     Typic  Hapludult      X    286.2
 305 HAYSUILLE             AC Clayey     Typic  Hapludult      X   1433.7
                                                   TOTAL AREA =   6009.8
**************************************************************************
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******************** GROUP       2 ... ACH ***************
  8 CASHIERS            AC Coarse-loamy  Umbric Dystrochrepts   X    19.3
  9 CASHIERS            AC Coarse-loamy  Umbric Dystrochrepts   X   119.7
 10 CASHIERS            AC Coarse-loamy  Umbric Dystrochrepts   X    49.2
241 PORTERS             AC Coarse-loamy  Umbric Dystrochrepts   X   187.0
242 PORTERS             AC Coarse-loamy  Umbric Dystrochrepts   X    10.4
240 PORTERS, STONY      AC Coarse-loamy  Umbric Dystrochrepts   X    12.6
 61 PORTERS, STONY      AC Coarse-loamy  Umbric Dystrochrepts   X   164.2
 62 PORTERS, STONY      AC Coarse-loamy  Umbric Dystrochrepts   X  1307.7
 63 PORTERS, STONY      AC Coarse-loamy  Umbric Dystrochrepts   X  1979.0
 68 SAUNOOK             AC Fine-loamy    Humic  Hapludults      U    40.8
 69 SAUNOOK             AC Fine-loamy    Humic  Hapludults      U   329.2
 70 SAUNOOK             AC Fine-loamy    Humic  Hapludults      U   135.8
286 SAUNOOK, STONY      AC Fine-loamy    Humic  Hapludults      U    85.8
 72 SAUNOOK, STONY      AC Fine-loamy    Humic  Hapludults      U    51.0
 73 SAUNOOK, STONY      AC Fine-loamy    Humic  Hapludults      U   219.3
 98 TRIMONT             AC Fine-loamy    Humic  Hapludults      X    95.4
 99 TRIMONT             AC Fine-loamy    Humic  Hapludults      X   241.4
259 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U    10.6
260 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U    66.0
261 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U   199.2
265 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U  1649.8
146 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U    44.0
 77 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U   163.3
148 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U    67.5
 79 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U   724.0
 81 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U   883.1
 83 TUSQUITEE           AC Coarse-loamy  Umbric Dystrochrepts   U   207.1
262 TUSQUITEE, STONY    AC Coarse-loamy  Umbric Dystrochrepts   U   204.4
264 TUSQUITEE, STONY    AC Coarse-loamy  Umbric Dystrochrepts   U    44.0
379 TUSQUITEE, STONY    AC Coarse-loamy  Umbric Dystrochrepts   U   146.4
263 TUSQUITEE, STONY    AC Coarse-loamy  Umbric Dystrochrepts   U    28.0
107 WHITESIDE           AC Coarse-loamy  Typic  Haplumbrepts    U    12.6
147 WHITESIDE           AC Coarse-loamy  Typic  Haplumbrepts    U    33.0
149 WHITESIDE           AC Coarse-loamy  Typic  Haplumbrepts    U   133.5
                                              TOTAL AREA =   9661.5
***********************************************************************
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******************** GROUP         3 ... ACL  **************
 183 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X     31.0
 184 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X    205.6
 185 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X    177.7
 342 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X    276.9
 344 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X    119.2
 173 ASHE                    AC Coarse-loamy   Typic  Dystrochrepts    X   1698.4
 189 ASHE, STONY             AC Coarse-loamy   Typic  Dystrochrepts    X    777.7
 365 BREVARD                 AC Fine-loamy     Typic  Hapludults       A      0.0
 193 BREVARD                 AC Fine-loamy     Typic  Hapludults       A    281.6
 194 BREVARD                 AC Fine-loamy     Typic  Hapludults       A    595.1
 195 BREVARD                 AC Fine-loamy     Typic  Hapludults       A    594.9
 196 BREVARD                 AC Fine-loamy     Typic  Hapludults       A    193.8
 202 CHANDLER                AC Coarse-loamy   Typic  Dystrochrepts    X    455.9
 201 CHANDLER                AC Coarse-loamy   Typic  Dystrochrepts    X    155.0
 203 CHANDLER                AC Coarse-loamy   Typic  Dystrochrepts    X    925.9
 399 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X   3207.0
  22 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X      9.3
 132 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X    108.5
  24 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X    173.2
 134 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X    749.9
  26 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X    236.0
 136 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X    978.8
  28 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X     89.4
 138 CHESTNUT, STONY         AC Coarse-loamy   Typic  Dystrochrepts    X   1350.0
  13 CHESTNUT, STONY, WINDSWEP AC Coarse-loamy Typic  Dystrochrepts    X      7.3
  15 CHESTNUT, STONY, WINDSWEP AC Coarse-loamy Typic  Dystrochrepts    X     73.0
  17 CHESTNUT, STONY, WINDSWEP AC Coarse-loamy Typic  Dystrochrepts    X     39.0
  19 CHESTNUT, STONY, WINDSWEP AC Coarse-loamy Typic  Dystrochrepts    X     40.0
 395 CHESTNUT, WINDSWEPT     AC Coarse-loamy   Typic  Dystrochrepts    X     34.0
  29 COWEE                   AC Fine-loamy     Typic  Hapludults       X    118.8
  35 COWEE                   AC Fine-loamy     Typic  Hapludults       X    492.9
 367 COWEE                   AC Fine-loamy     Typic  Hapludults       X    120.6
 375 COWEE                   AC Fine-loamy     Typic  Hapludults       X    790.7
 377 COWEE                   AC Fine-loamy     Typic  Hapludults       X    311.3
  31 COWEE                   AC Fine-loamy     Typic  Hapludults       X    559.8
  33 COWEE                   AC Fine-loamy     Typic  Hapludults       X   1199.4
  37 COWEE, STONY            AC Fine-loamy     Typic  Hapludults       X      9.3
  41 COWEE, STONY            AC Fine-loamy     Typic  Hapludults       X    159.7
 307 COWEE, STONY            AC Fine-loamy     Typic  Hapludults       X    460.0
 308 COWEE, STONY            AC Fine-loamy     Typic  Hapludults       X      5.5
 218 EDNEYVILLE              AC Coarse-loamy   Typic  Dystrochrepts    X     67.0
 219 EDNEYVILLE              AC Coarse-loamy   Typic  Dystrochrepts    X    841.7
 346 EDNEYVILLE              AC Coarse-loamy   Typic  Dystrochrepts    X    962.8
 217 EDNEYVILLE              AC Coarse-loamy   Typic  Dystrochrepts    X     27.5
 345 EDNEYVILLE              AC Coarse-loamy   Typic  Dystrochrepts    X    636.7
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(CONTINUED)

131	EDNEYVILLE, STONY	AC	Coarse-loamy	Typic	Dystrochrepts	X	139.5
133	EDNEYVILLE, STONY	AC	Coarse-loamy	Typic	Dystrochrepts	X	947.1
135	EDNEYVILLE, STONY	AC	Coarse-loamy	Typic	Dystrochrepts	X	2153.9
137	EDNEYVILLE, STONY	AC	Coarse-loamy	Typic	Dystrochrepts	X	1813.9
14	EDNEYVILLE, STONY, WINDSW	AC	Coarse-loamy	Typic	Dystrochrepts	X	7.3
16	EDNEYVILLE, STONY, WINDSW	AC	Coarse-loamy	Typic	Dystrochrepts	X	43.8
18	EDNEYVILLE, STONY, WINDSW	AC	Coarse-loamy	Typic	Dystrochrepts	X	31.2
20	EDNEYVILLE, STONY, WINDSW	AC	Coarse-loamy	Typic	Dystrochrepts	X	32.0
30	EVARD	AC	Fine-loamy	Typic	Hapludults	X	110.0
36	EVARD	AC	Fine-loamy	Typic	Hapludults	X	473.4
151	EVARD	AC	Fine-loamy	Typic	Hapludults	X	151.6
167	EVARD	AC	Fine-loamy	Typic	Hapludults	X	41.7
221	EVARD	AC	Fine-loamy	Typic	Hapludults	X	1328.1
222	EVARD	AC	Fine-loamy	Typic	Hapludults	X	2376.9
223	EVARD	AC	Fine-loamy	Typic	Hapludults	X	1483.0
364	EVARD	AC	Fine-loamy	Typic	Hapludults	X	174.2
353	EVARD	AC	Fine-loamy	Typic	Hapludults	X	4.4
220	EVARD	AC	Fine-loamy	Typic	Hapludults	X	553.0
165	EVARD	AC	Fine-loamy	Typic	Hapludults	X	10.8
355	EVARD	AC	Fine-loamy	Typic	Hapludults	X	8.8
32	EVARD	AC	Fine-loamy	Typic	Hapludults	X	358.0
34	EVARD	AC	Fine-loamy	Typic	Hapludults	X	1019.9
159	EVARD	AC	Fine-loamy	Typic	Hapludults	X	41.4
171	EVARD, STONY	AC	Fine-loamy	Typic	Hapludults	X	181.7
226	FANNIN	AC	Fine-loamy	Typic	Hapludults	X	282.1
227	FANNIN	AC	Fine-loamy	Typic	Hapludults	X	752.1
229	FANNIN	AC	Fine-loamy	Typic	Hapludults	X	783.5
228	FANNIN	AC	Fine-loamy	Typic	Hapludults	X	1571.4
					TOTAL AREA =		37231.1

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******************** GROUP        4 ... FL   **************
 108 ARKAQUA, FREQ FLOODED     Y4 Fine-loamy     Fluvaq Dystrochrepts    A    126.0
 363 ARKAQUA, OCC FLOODED      Y4 Fine-loamy     Fluvaq Dystrochrepts    A    376.8
 347 ARKAQUA, OCC FLOODED      Y4 Fine-loamy     Fluvaq Dystrochrepts    A      0.0
 349 ARKAQUA, OCC FLOODED      Y4 Fine-loamy     Fluvaq Dystrochrepts    A      9.6
 310 ARKAQUA, OCC FLOODED      Y4 Fine-loamy     Fluvaq Dystrochrepts    A    215.2
 190 BILTMORE                  Y4 Sandy          Typic  Udifluvents      A     37.2
  12 CHATUGE, RARELY FLOODED   Y4 Fine-loamy     Typic  Ochraquults      A     55.1
 180 COLVARD, OCC FLOODED      Y4 Coarse-loamy   Typic  Udifluvents      A     71.7
 309 COLVARD, OCC FLOODED      Y4 Coarse-loamy   Typic  Udifluvents      A     57.7
  45 CULLOWHEE, OCC FLOODED    Y4 Coarse-loamy   Fluven Humaquepts       A    233.2
 213 DILLARD, RARELY FLOODED   AC Fine-loamy     Aquic  Hapludults       A      0.0
 214 DILLARD, RARELY FLOODED   AC Fine-loamy     Aquic  Hapludults       A    303.4
 230 FRENCH                    Y4 Fine-loamy ove Fluvaq Dystrochrepts    A    147.0
 235 IOTLA                     Y4 Coarse-loamy   Aquic  Udifluvents      A     23.2
 142 NIKWASI, FREQ FLOODED     Y4 Coarse-loamy   Cumuli Humaquepts       A    300.3
 411 PHILO                     Y4 Coarse-loamy   Fluvaq Dystrochrepts    A     20.4
 359 POPE, OCC FLOODED         Y4 Coarse-loamy   Fluven Dystrochrepts    A    173.4
 143 REDDIES, FREQ FLOODED     Y4 Coarse-loamy   Fluven Haplumbrepts     A    181.6
 314 ROSMAN, FREQ FLOODED      Y4 Coarse-loamy   Fluven Haplumbrepts     A     65.9
 315 STATLER, RARELY FLOODED   AC Fine-loamy     Humic  Hapludults       A     89.7
 394 SUCHES                    AC Fine-loamy     Fluven Dystrochrepts    A      0.0
 361 SUCHES                    AC Fine-loamy     Fluven Dystrochrepts    A     47.1
 168 SUCHES, OCC FLOODED       Y4 Fine-loamy     Fluven Dystrochrepts    A    390.0
 350 SUCHES, OCC FLOODED       Y4 Fine-loamy     Fluven Dystrochrepts    A     26.4
  92 SYLVA                     AC Coarse-loamy   Typic  Humaquepts       V     12.2
 257 TOXAWAY, FREQ FLOODED     Y4 Fine-loamy     Cumuli Humaquepts       A     84.3
 258 TRANSYLVANIA              Y4 Fine-loamy     Cumuli Haplumbrepts     A     36.0
                                                          TOTAL AREA =   3083.3
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******************** GROUP         5 ... FR  **************
   1 BURTON, STONY             AM Coarse-loamy   Typic  Haplumbrepts     X     79.9
   3 BURTON, STONY             AM Coarse-loamy   Typic  Haplumbrepts     X     57.5
   5 BURTON, STONY             AM Coarse-loamy   Typic  Haplumbrepts     X    182.0
 211 CRAGGEY                   AM Loamy          Lithic Haplumbrepts     X    195.3
 301 CRAGGEY                   AM Loamy          Lithic Haplumbrepts     X   1051.3
   2 CRAGGEY, STONY            AM Loamy          Lithic Haplumbrepts     X     68.9
   4 CRAGGEY, STONY            AM Loamy          Lithic Haplumbrepts     X     26.6
   6 CRAGGEY, STONY            AM Loamy          Lithic Haplumbrepts     X     13.7
 410 LITHIC BOROFOLISTS        KO                Lithic Borofolists      O      1.4
 415 LITHIC BOROFOLISTS        KO                Lithic Borofolists      O      5.8
 420 LITHIC DYSTROCHREPTS      MS Loamy-skeletal Lithic Dystrochrepts    X      8.9
 331 LITHIC DYSTROCHREPTS      MS Loamy-skeletal Lithic Dystrochrepts    X    204.2
 326 LITHIC HAPLORTHODS        MS Loamy-skeletal Lithic Haplorthods      X     23.8
  56 OCONALUFTEE               MS Coarse-loamy   Typic  Haplumbrepts     X    158.9
  97 TANASEE, STONY            AC Coarse-loamy   Typic  Haplumbrepts     U     30.9
 416 TYPIC DYSTROCHREPT        MS Coarse-loamy   Typic  Dystrochrepts    X      9.0
 409 TYPIC HAPLORTHOD          MS Loamy-skeletal Typic  Haplorthod       X      2.8
 327 TYPIC HAPLUMBREPTS        MS Loamy-skeletal Typic  Haplumbrepts     U     49.3
 329 UMBRIC DYSTROCHREPTS      MS Loamy-skeletal Umbric Dystrochrepts    U     80.1
 389 UMBRIC DYSTROCHREPTS      MS Coarse-loamy   Umbric Dystrochrepts    X      8.0
 330 UMBRIC DYSTROCHREPTS      MS Loamy-skeletal Umbric Dystrochrepts    U   1156.8
 300 UMBRIC DYSTROCHREPTS      MS Loamy-skeletal Umbric Dystrochrepts    U   1048.4
 328 UMBRIC DYSTROCHREPTS, STO MS Coarse-loamy   Umbric Dystrochrepts    X     76.5
 102 WAYAH                     AC Coarse-loamy   Typic  Haplumbrepts     X    245.7
 103 WAYAH, WINDSWEPT          AC Coarse-loamy   Typic  Haplumbrepts     X    277.2
 104 WAYAH, WINDSWEPT          AC Coarse-loamy   Typic  Haplumbrepts     X    212.8
                                                        TOTAL AREA =   5267.7
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******************** GROUP        6 ... MSH **************
 352 BROOKSHIRE                 MS Coarse-loamy  Umbric Dystrochrepts   U     68.0
 289 BROOKSHIRE                 MS Coarse-loamy  Umbric Dystrochrepts   U    365.5
 291 BROOKSHIRE                 MS Coarse-loamy  Umbric Dystrochrepts   U     96.4
 293 BROOKSHIRE                 MS Coarse-loamy  Umbric Dystrochrepts   U    245.5
 332 BROOKSHIRE, BOULDERY       MS Coarse-loamy  Umbric Dystrochrepts   A   1929.5
 127 CHEOAH                     MS Coarse-loamy  Typic  Haplumbrepts    X     30.0
 126 CHEOAH                     MS Coarse-loamy  Typic  Haplumbrepts    X    304.9
 128 CHEOAH                     MS Coarse-loamy  Typic  Haplumbrepts    X    362.4
 178 CHEOAH, WINDSWEPT          MS Coarse-loamy  Typic  Haplumbrepts    X     92.9
 239 JEFFREY                    MS Coarse-loamy  Umbric Dystrochrepts   X   1336.8
 238 JEFFREY                    MS Coarse-loamy  Umbric Dystrochrepts   X      8.4
 316 JEFFREY                    MS Coarse-loamy  Umbric Dystrochrepts   X   1189.8
 385 SANTEELAH                  MS Coarse-loamy  Typic  Haplumbrepts    U    209.2
 281 SANTEETLAH                 MS Coarse-loamy  Typic  Haplumbrepts    U     65.9
 283 SANTEETLAH                 MS Coarse-loamy  Typic  Haplumbrepts    U    296.0
 285 SANTEETLAH                 MS Coarse-loamy  Typic  Haplumbrepts    U    595.5
 294 SANTEETLAH                 MS Coarse-loamy  Typic  Haplumbrepts    U    144.9
 408 UMBRIC DYSTROCHREPT        MS Coarse-loamy  Umbric Dystrochrepts   X    228.3
 417 UMBRIC DYSTROCHREPTS       MS Coarse-loamy  Umbric Dystrochrepts   X      4.5
 414 UMBRIC DYSTROCHREPTS, SHR  MS Loamy         Umbric Dystrochrepts   X      8.8
 362 WELCHLAND                  MS Coarse-loamy  Humic  Hapludult       A    164.0
                                                      TOTAL AREA =   7747.2

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********************* GROUP          7 ... MSL  ***************
 303 ALLEGHENY                  MS Fine-loamy    Typic  Hapludults       A    248.1
 304 ALLEGHENY                  MS Fine-loamy    Typic  Hapludults       A     38.7
 383 ALLEGHENY                  MS Fine-loamy    Typic  Hapludults       A     50.7
  47 BRASSTOWN                  MS Fine-loamy    Typic  Hapludults       X      5.5
  49 BRASSTOWN                  MS Fine-loamy    Typic  Hapludults       X     75.0
  51 BRASSTOWN                  MS Fine-loamy    Typic  Hapludults       X    176.8
  53 BRASSTOWN                  MS Fine-loamy    Typic  Hapludults       X     81.1
 216 DITNEY                     MS Coarse-loamy  Typic  Dystrochrepts    X   1118.6
 215 DITNEY                     MS Coarse-loamy  Typic  Dystrochrepts    X     50.4
 322 DITNEY                     MS Coarse-loamy  Typic  Dystrochrepts    X    803.8
 357 FLETCHER                   MS Fine-silty    Typic  Hapludults       X    298.4
 236 JEFFERSON                  MS Fine-loamy    Typic  Hapludults       U    209.9
 306 JEFFERSON                  MS Fine-loamy    Typic  Hapludults       U      8.7
 237 JEFFERSON                  MS Fine-loamy    Typic  Hapludults       U    598.4
  46 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X      0.0
  48 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X      0.0
  50 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X      0.0
  52 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X      0.0
 272 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X     25.0
 274 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X    250.0
 276 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X    686.2
 278 JUNALUSKA                  MS Fine-loamy    Typic  Hapludults       X    646.8
 337 NAUVOO                     MS Fine-loamy    Typic  Hapludults       X    147.1
 338 NAUVOO                     MS Fine-loamy    Typic  Hapludults       X     38.1
 373 NAUVOO                     MS Fine-loamy    Typic  Hapludults       X     60.9
 287 SHELOCTA                   MS Fine-loamy    Typic  Hapludults       U    127.0
 288 SHELOCTA                   MS Fine-loamy    Typic  Hapludults       U    217.4
  89 SOCO                       MS Coarse-loamy  Typic  Dystrochrepts    X    379.1
  91 SOCO                       MS Coarse-loamy  Typic  Dystrochrepts    X    333.1
  87 SOCO                       MS Coarse-loamy  Typic  Dystrochrepts    X      6.2
  86 STECOAH                    MS Coarse-loamy  Typic  Dystrochrepts    X     93.7
  88 STECOAH                    MS Coarse-loamy  Typic  Dystrochrepts    X    371.6
  90 STECOAH                    MS Coarse-loamy  Typic  Dystrochrepts    X   1409.2
 273 TSALI                      MS Loamy         Typic  Hapludults       X     25.0
 275 TSALI                      MS Loamy         Typic  Hapludults       X    175.0
 336 TSALI                      MS Loamy         Typic  Hapludults       X     65.0
 277 TSALI                      MS Loamy         Typic  Hapludults       X    686.2
 279 TSALI                      MS Loamy         Typic  Hapludults       X    567.7
 325 TYPIC DYSTROCHREPTS        MS Fine-loamy    Typic  Dystrochrepts    U    149.6
 413 TYPIC DYSTROCHREPTS, SHAL  MS Loamy         Typic  Dystrochrepts    U     17.6
                                                         TOTAL AREA =  10323.6

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******************** GROUP        8 ... OTC **************
 320 DANDRIDGE               H2 Clay-skeletal  Lithic Eutrochrepts     X    308.2
 348 HAMBLEN, OCC FLOODED    MS Fine-loamy     Fluvaq Eutrochrept      A      2.4
 318 HAMBLEN, OCC FLOODED    MS Fine-loamy     Fluvaq Eutrochrept      A    168.4
 407 LITZ                    H2 Loamy-skeletal Ruptic Dystrochrepts    X     17.1
 412 MUSE                    H2 Clayey         Typic  Hapludult        V     36.8
 319 SEQUOIA VARIENT         H2 Clayey         Typic  Hapludults       X    346.9
                                                       TOTAL AREA =    879.8
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******************** GROUP        9 ... OTL **************
 335 ALTICREST               AO Coarse-loamy   Typic  Dystrochrepts    X      3.3
 372 ALTICREST               AO Coarse-loamy   Typic  Dystrochrepts    X    101.8
 424 MAYMEADE                AM Coarse-loamy   Typic  Dystrochrepts    V     44.2
 406 MAYMEADE                AM Coarse-loamy   Typic  Dystrochrepts    V    441.3
 423 MAYMEADE                AM Coarse-loamy   Typic  Dystrochrepts    V    250.0
 419 MAYMEADE                AM Coarse-loamy   Typic  Dystrochrepts    V    220.4
 341 PITS, ROCK QUARRY                                                       57.0
  64 ROCK OUTCROP                                                            99.0
  66 ROCK OUTCROP                                                           205.0
 175 ROCK OUTCROP                                                           849.2
 198 ROCK OUTCROP                                                            11.7
 200 ROCK OUTCROP                                                            15.2
 212 ROCK OUTCROP                                                            45.1
 246 ROCK OUTCROP                                                            19.4
 249 ROCK OUTCROP                                                            16.1
 298 ROCK OUTCROP                                                           119.9
 323 ROCK OUTCROP                                                           267.6
 392 ROCK OUTCROP                                                           125.0
 302 ROCK OUTCROP                                                           393.1
 371 ROCK OUTCROP                                                             9.9
 339 TALLANT                 BO Fine-loamy     Typic  Hapludults       X    120.8
 340 TALLANT                 BO Fine-loamy     Typic  Hapludults       X    152.4
 401 TALLANT                 BO Fine-loamy     Typic  Hapludults       X     15.8
 374 TALLANT                 BO Fine-loamy     Typic  Hapludults       X     25.9
 254 TATE                    AM Fine-loamy     Typic  Hapludults       V    245.2
 290 TATE                    AM Fine-loamy     Typic  Hapludults       V    103.8
 255 TATE                    AM Fine-loamy     Typic  Hapludults       V    651.9
 256 TATE                    AM Fine-loamy     Typic  Hapludults       V    722.4
 398 TATE                    AM Fine-loamy     Typic  Hapludults       V    137.9
 292 TATE                    AM Fine-loamy     Typic  Hapludults       V    285.8
 403 TATE                    AM Fine-loamy     Typic  Hapludults       V    240.0
                                                       TOTAL AREA =   6001.1
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******************* GROUP       10 ... SHL *************
  65 CLEVELAND            AC Loamy         Lithic Dystrochrepts    X      0.0
  67 CLEVELAND            AC Loamy         Lithic Dystrochrepts    X    572.2
 343 CLEVELAND            AC Loamy         Lithic Dystrochrepts    X    120.5
 174 CLEVELAND            AC Loamy         Lithic Dystrochrepts    X   1273.8
  21 CLEVELAND, STONY     AC Loamy         Lithic Dystrochrepts    X     31.0
  27 CLEVELAND, STONY     AC Loamy         Lithic Dystrochrepts    X    175.1
  23 CLEVELAND, STONY     AC Loamy         Lithic Dystrochrepts    X    410.9
  25 CLEVELAND, STONY     AC Loamy         Lithic Dystrochrepts    X    413.6
 370 RAMSEY               MS Loamy         Lithic Dystrochrepts    X     19.8
 333 RAMSEY               MS Loamy         Lithic Dystrochrepts    X     12.3
 369 RAMSEY, STONY        MS Loamy         Lithic Dystrochrepts    X      8.4
 334 RAMSEY, STONY        MS Loamy         Lithic Dystrochrepts    X     57.4
 366 SALUDA               AC Loamy         Typic  Hapludults       X     32.5
 376 SALUDA               AC Loamy         Typic  Hapludults       X    359.1
 378 SALUDA               AC Loamy         Typic  Hapludults       X    133.0
 381 SALUDA               AC Loamy         Typic  Hapludults       X      4.4
 164 SALUDA               AC Loamy         Typic  Hapludults       X     99.4
 166 SALUDA               AC Loamy         Typic  Hapludults       X    250.0
 248 SALUDA               AC Loamy         Typic  Hapludults       X     14.2
  40 SALUDA, STONY        AC Loamy         Typic  Hapludults       X    102.3
  42 SALUDA, STONY        AC Loamy         Typic  Hapludults       X     57.5
  44 SALUDA, STONY        AC Loamy         Typic  Hapludults       X     51.2
                                                   TOTAL AREA =   4198.5
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******************** GROUP        11 ... SKU **************
  129 DELLWOOD, FREQ FLOODED    Y4 Sandy-skeletal Fluven Haplumbrepts    A    231.2
  311 GREENLEE, VERY STONY      AC Loamy-skeletal Typic  Dystrochrepts   V     40.0
  312 GREENLEE, VERY STONY      AC Loamy-skeletal Typic  Dystrochrepts   V    206.5
  402 GREENLEE, VERY STONY      AC Loamy-skeletal Typic  Dystrochrepts   V   1066.5
  313 GREENLEE, VERY STONY      AC Loamy-skeletal Typic  Dystrochrepts   V    855.4
  425 KISTLER                   MS Loamy-skeletal Typic  Dystrochrepts   V      9.7
  271 KISTLER                   MS Loamy-skeletal Typic  Dystrochrepts   V    324.4
  280 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V     68.0
  393 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V    622.0
   76 SPIVEY                    AC Loamy-skeletal Typic  Haplumbrepts    V    208.3
  282 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V    207.0
   78 SPIVEY                    AC Loamy-skeletal Typic  Haplumbrepts    V   1361.7
  360 SPIVEY                    AC Loamy-skeletal Typic  Haplumbrepts    V    233.4
  284 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V    768.2
   80 SPIVEY                    AC Loamy-skeletal Typic  Haplumbrepts    V    970.9
  317 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V    913.2
  384 SPIVEY                    MS Loamy-skeletal Typic  Haplumbrepts    V    323.9
   82 SPIVEY                    AC Loamy-skeletal Typic  Haplumbrepts    V    535.1
   74 SPIVEY, EXTREMELY BOULDER AM Loamy-skeletal Typic  Haplumbrepts    V   1904.0
  250 SPIVEY, VERY STONY        AC Loamy-skeletal Typic  Haplumbrepts    V     25.8
  251 SYLCO                     MS Loamy-skeletal Typic  Dystrochrepts   X    370.9
                                                    TOTAL AREA =  11253.9
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******************** GROUP        12 ... SKX **************
  115 CATASKA                   MS Loamy-skeletal Typic  Dystrochrepts   X     27.9
  199 CATASKA                   MS Loamy-skeletal Typic  Dystrochrepts   X     45.6
  117 CATASKA                   MS Loamy-skeletal Typic  Dystrochrepts   X    225.7
  267 RANGER                    MS Loamy-skeletal Ruptic Dystrochrepts   X    982.6
  116 SYLCO                     MS Loamy-skeletal Typic  Dystrochrepts   X     21.7
  118 SYLCO                     MS Loamy-skeletal Typic  Dystrochrepts   X     52.6
  253 TALLADEGA                 MS Loamy-skeletal Ruptic Hapludults      X    241.4
  295 UNICOI                    MS Loamy-skeletal Lithic Dystrochrepts   X     52.2
  297 UNICOI                    MS Loamy-skeletal Lithic Dystrochrepts   X    205.8
  296 UNICOI                    MS Loamy-skeletal Lithic Dystrochrepts   X    150.4
  321 UNICOI                    MS Loamy-skeletal Lithic Dystrochrepts   X    713.6
                                                    TOTAL AREA =   2719.5
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APPENDIX B

ADDENDUM TO THE PROTOCOLS

Section 1.0

Page 2 of 3, last paragraph, line 1: Change "project leader" to "technical director."

Page 3 of 3, last paragraph: Change to "The objective of this manual is to emphasize and modify National Cooperative Soil Survey procedures as is necessary to characterize and sample soils for the DDRP Soil Survey. This manual is written to an audience of soil scientists with experience in soil description, soil sampling, and laboratory preparation, and knowledgeable of NCSS procedures. Because this namual supplements NCSS handbooks and manuals, one may want to refer to them for more complete description and definitions.

Soils which have been identified in the SBRP have been combined into groups, or sampling classes, which are either known or expected to have sinilar chemical and physical characteristics. Each of the sampling classes can then be sampled across a number of watersheds in which it occurs. Note that in this approach, a given soil sample does not represent the specific watershed from which it came. Instead it contributes to a set of samples which, collectively, represents a specific sampling class on all DDRP watersheds within SBRP.

Section 2.0

Section 2.1.1, Third responsibility: "Ensure that site and pedon descriptions, log books, and pedon labels are legible and accurate and that photographs are taken correctly."

Sixth responsibility: "Maintain sample integrity (primarily by storage at 4°C..."

Section 2.1.3, Page 3 of 8, line 2: "...document, and will perform an independent duplicate profile description."
Section 2.2.1, Line 5: Change "Compass" to "Compass - (true north, adjust for declination)."
Section 2.2.3, Line 6: Change "Magnetic compass" to "compass - (true north, adjust for declination)."
Section 2.2.4, Line 2: Change "ASA-400" to "ASA-200."
Section 2.2.7, Line 3 Change to "Gel pacs (24 per day or 6 per cooler)."

Section 3.0

Page 4 of 6, second paragraph: Change to "Starting point - The starting point is the first potential sampling point, located at the center of each sampling site."

Step 4: second bullet, first line: Change to "Transect potential sampling points in 10 m intervals along a 150 m straight line . . ."

fourth line: Omit "within 5 m of the line." Eliminate next sentence.

eighth line: After "transects" add "(a total of 76 potential sampling points)"

third bullet: Change to: "Record on the SCS-232 Form in the LOG SECTION, the direction of each transect and the number of the sampling point (do not record meters) on the last transect. Use N for north, NE for northeast and so forth. An example could be: SW, N, E, SE-7.

fourth bullet: Eliminate "QA Manager"

Page 5 of 6, Step 4, 3rd paragraph: Change to: "1 represents northeast, 2 is east, 3 is southeast." The numbers represent the directions as described in the Slope Aspect Codes of the SCS-232 form.

Page 6 of 6: Add the following new section:

3.3 Locating a suitable pedon of a map unit inclusion.

Where insufficient map polygons are available to sample the soil class from major map unit components, the pedons must be sampled from map unit inclusions. Some of the pedons for the calcareous (OTC) sampling class will be collected from inclusions. To locate a suitable pedon for sampling from an inclusion go to an area nearest the preselected sampling site within the map polygon where a soil that fits the class is expected to be located. If a suitable pedon cannot be located near the first sample site go to the next site.

Page 6 of 6, line 8: Change "3.3 Paired Pedons" to "3.4 Paired Pedons"

line 10: Change the sentence in parens to read "(Paired pedons are selected by sampling class and watershed and are selected and assigned in advance by ERL-C)."

Section 5.0

Section 5.2, page 4 of 7, line 6: After "face." add "Note that the khaki measuring tape is made to be placed at the left of the profile due to the way the intervals are marked."

last line: After "code" add "what the slide is," Page 5 of 7, last line of 1st paragraph: Add "Slide numbers are also to be recorded in the Log Section of the 232 Form (page 4 of 4)."

Section 5.3, Page 6 of 7, paragraph 1: Change references to agree with the reference list in Section 12.0, page 1 of 1.

Section 6.0

Section 6.0, line 1: Change "to the collect" to "to collect"

line 3: Omit the word "Also"

6.1.1, line 4: Reference (1984b) is not consistent with reference list in Section 12.0.

6.1.2, lines 4-6: Change to "Soil samples should be collected from major horizons to bedrock or to a depth of 2 m from freshly dug pits that expose a clean vertical face about 1 m wide."

page 2 of 10, paragraph 2: After "three" add "fist-sized"

Section 6.3, page 3 of 10, first paragraph: Change to "Horizons should be sampled in a sequence that minimizes sample contamination and is most practical. Sampling may expose spatial variability that was not accounted for in the initial profile description. Descriptions should be modified to reflect this situation."

Section 6.3, paragraph 2, line 3: Change "shall" to "may"

Third paragraph, lines 3-4: Change sentence to "Place the soil fraction passing the 20-mm sieve in the sample bag."

Page 4 of 10: After 6.3.1, add the following section

6.3.2 Field Duplicates

Sample one horizon per day in duplicate. This will be the field duplicate. Different horizons should be chosen from day to day, so that all horizons are duplicated during sampling.

To obtain a true horizon duplicate, alternate trowel - fulls or dust - pan loads into 2 piles or into 1-gallon buckets. Sieve and place in separate sample bags; label one as a routine sample and the other as a field duplicate. (See Section 6.6 for labeling instructions).

Section 6.4.1, page 5 of 10, 1st paragraph: Delete 6th sentence "Record the number of times a clod is dipped on the label." - add "It is recommended to dip clods once; if necessary to dip more than once, note the number of times on the clod label."

Section 6.6, page 7 of 10: Delete digit 8 under node number.

Section 6.6, page 8 of 10: Below "6.6" Add "6.6.1 Filling Out Label" Add Section 6.6.2.

6.6.2 Examples of filled out lables

SINGLE HORIZON

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 1 1 T N 0 1 7 0 0 3 0 6

Horizon: C _ _ _ Depth: 1 4 0 - 2 0 0 cm

Set ID: 0 2 0 9 9

FIELD DUPLICATE HORIZON

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: F D 0 T N 0 1 7 0 0 3 0 6

Horizon: C _ _ _ Depth: 1 4 0 - 2 0 0 cm

Set ID: 0 2 0 9 9

HORIZON CONTAINING TWO SAMPLE BAGS

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 1 2 T N 0 1 7 0 0 3 0 2

Horizon: 0 e _ _ Depth: 0 0 0 - 0 0 5 cm

Set ID: 0 2 0 9 9

NADSS Label A

Date Sampled: 1 0 A P R 8 6
D D M M M Y Y

Crew ID: T N 0 1

Site ID: 2 A 0 7 9 0 7

Sample Code: R 2 2 T N 0 1 7 0 0 3 0 2

Horizon: 0 e _ _ Depth: 0 0 0 - 0 0 5 cm

Set ID: 0 2 0 9 9

COMBINED HORIZON

NADSS Label A

Date Sampled: 11APR86
DDMMMYY

Crew ID: TN01

Site ID: 2A07907

Sample Code: R12TN01700402
R12TN01700403

Horizon: 0e__ Depth: 000-005
0a 002-005

Set ID: 02001

NADSS Label A

Date Sampled: 11APR86
DDMMMYY

Crew ID: TN01

Site ID: 2A07907

Sample Code: R22TN01700402
R22TN01700403

Horizon: 0e__ Depth: 000-002 cm
0a 002-005

Set ID: 02001

APPENDIX C

SPECIAL INTEREST WATERSHEDS

INTRODUCTION

Three special interest watersheds in the southeastern United States were selected for sampling as part of DDRP. Two of the watersheds, i.e., Coweeta #34 and #36, are located at the USDA Forest Service Coweeta Hydrologic Laboratory near Franklin, North Carolina; the third watershed, White Oak Run, is located in Rockingham County, Virginia.

Because special interest watersheds are sampled to fulfill the data requirements for calibration of the acidic deposition response models, the sampling sites in special interest eatersheds are not selected randomly. Instead, the sampling crew is directed to a specific point and is instructed to sample a soil that was chosen to represent the specific watershed or portion of the watershed from which it is sampled.

This appendix documents changes that were necessary in the QA plan and the routine protocols to account for the differences in the sampling of special interest watersheds. Also, the documentation provided by the sampling crews is included.

MODIFICATIONS TO THE QUALITY ASSURANCE PLAN

Section 1.0 Intended Use of Data

No changes are required.

Section 2.0 Criteria for Site Selection.

Replace these criteria with the following:

The purpose of sampling soils in the special interest watersheds is to provide detailed physical, chemical, and mineralogical information about the soils in each watershed sampled. Unlike routine soil samples, the soil samples collected in the special interest watersheds should characterize the chemically and hydrologically important soils in the particular watershed. This is different from the objective of the general soil survey which was intended to characterize soils on a regional basis.

It is appropriate to use a model-based sampling approach as opposed to a probability sampling design. The probability structure defines the relationship of the sample to the target population. The probability structure carries the burden of inference. In the present case, the model is the synthesis of the experience of the watershed modelers. Because this is highly subjective, the persons most familiar with the soils within each special interest watershed are asked to locate the sampling sites using their discretion. The sampling site selection guidelines are described below:

- One of the five soil pedons will be taken from and represent the most important stream headwater soil.
- Two pedons will be taken in the near channel wetland: one near a low order part of the stream, and one from a higher order position. Each pedon should represent the most important soils that conduct soil water by saturated flow.

- Two pedons will be taken from backslope positions on opposite sides of the stream. Each pedon will represent the most important hillslope soil.

As mentioned above, the soil scientist sampling the special interest watersheds will be responsible for locating the sampling sites. The soil scientist will document why each sampling site was selected. This documentation must be sufficient to provide others with a reasonable sense of the logic behind the sample site selection.

Section 3.0 Data Quality Objectives

The first paragraph under 3.1 Introduction does not apply. The remainder of Section 3.0 applies to special interest watersheds.

Section 4.0 Methods and Procedures

Modifications to the sampling protocols for southeastern special interest watersheds are listed below:

- Select sampling sites by location, not by soil type. This is an iterative process involving ERL-C and SCS soil scientists. A general soils map indicating the five sampling regions within each special interest watershed is supplied to the sampling crew leader by ERL-C. The final location of the sampling site is made by the crew leader and should reflect the concept of the sampling region. The crew leader must document the logic behind the final sampling site selected. This documentation should be sent to ERL-C.
- Split all soil horizons that are thicker than 20 cm for sampling.
- Collect representative rock fragments greater than 76 mm from the pedon to enable ERL-C scientists to identify bedrock geology. No more than than a kilogram of rock fragments is necessary from any one horizon.
- After the standard l- by 2- by 2-meter soil pit is excavated and the pedon is described and sampled, attempt to sample the saprolite and, if possible, to bedrock, in at least two of the five pedon sites by using a bucket auger with extension handles. In general, the soils near the stream will tend to contain a considerable amount of rock fragments that may impede or may prevent the use of the hand auger. Consequently, the soils near the stream may be unsuitable for deep sampling. The crew leader will select the two sites at which the sampling to bedrock will occur.
- Collecting samples from the bottom of the soil pit with a bucket auger requires special consideration. In general, a sample will require several bucketsful of soil material to be collected. The soil scientist must use discretion in separating this material into discrete samples. Samples should be homogeneous in color, texture, and general appearance. This may be facilitated by placing sequential bucketfuls of soil material on a plastic sheet. It is unnecessary to collect more than one gallon of sample material; however, when it is not possible to collect one gallon, collect as much sample as possible. The depth should be recorded on the field data form for all deep samples, and the samples should be processed in the field, i.e., sieved, bagged, and labeled, in the same manner as routine samples. Special sample number designations will be provided for these samples. The preparation laboratory will receive instructions on how to handle deep samples because the samples will be used only in mineralogical analyses.

5.0 QA/QC Procedures

Section 4.1.4, "Quality Assurance/Quality Control Auditor" does not apply. The remainder of Section 5.0 applies to special interest watersheds.

SITE SELECTION FOR COWEETA WATERSHEDS #34 AND #36

Selection Criteria and Site Descriptions

(1) Site NC113012 in Watershed #34 and Site NC113017 in Watershed #36 were selected to represent the warmer upland part of the landscape. These sites had warm vegetation, i.e., Chestnut Oak, Scarlet Oak, Hickory. Soils on these landscapes have ochric epipedon and cambic B horizons. The Cr horizon is generally at a depth of 40 to 60 inches or 20 to 40 inches from the soil surface. Most of the water movement in these soils is by unsaturated flow. All the watersheds are on forest land and are not graded. Ground cover is good. Runoff is low.

(2) Site NC113013 in Watershed #34 and Site NC113018 in Watershed #36 were selected to represent the lower part of the colluvial material in the lower part of the drainage area. These sites had cool vegetation, i.e., Yellow Poplar, Black Birch, Eastern Hemlock, Northern Red Oak, Sugar Maple. Soils on these landscapes have umbric epipedons and cambic B horizons. These soils have a layer of skeletal material. These skeletal layers commonly occur at a depth of 20 to 40 inches or 40 to 60 inches from the soil surface. These skeletal layers commonly have saturated flow at some time in the year. The water flowing in these layers does not always cause these layers to be grey in color. These areas had a thick canopy and understory. Runoff is slow even though these areas had some overland flow.

(3) Site NC113014 in Watershed #34 and Site NC113020 in Watershed #36 were selected to represent the cooler upland part of the landscape. These sites have cool vegetation, i.e, Northern Red Oak, Black Birch, Sugar Maple. Soils on these landscapes have umbric epipedons and cambic B horizons. The Cr horizon is generally at a depth of 40 inches or greater. Most of the water movement is by unsaturated flow. All the watersheds are forested. Groundcover is very good, and runoff is slow.

(4) Site NC113016 in Watershed #34 and Site NC113019 in Watershed #36 were selected to represent the upper part of the colluvial landscape in the upper part of the watershed. These sites have cool vegetation, i.e., Black Birch, Yellow Birch, Northern Red Oak, Yellow Poplar, Eastern Hemlock. Soils on these landscapes have umbric epipedons and cambic B horizons. These soils have a layer of skeletal material commonly at 20 to 40 inches or at 40 to 60 inches from the soil surface. These layers commonly have saturated flow some time during the year. These layers do not always have grey colors. The water is apparently well oxygenated. All these areas had a thick canopy and understory. Runoff is slow even though these areas have some overland flow.

(5) Site NC113015 in Watershed #34 and Site NC113021 in Watershed #36 were selected to represent the headwall of the watersheds. Because of the difference in elevation between NC113015 and NC113021, the vegetation was different. Site NC113015 has Chestnut Oak, Hickory, and some Yellow Poplar. Site NC113021 has Northern Red Oak, Maple, and Black Birch. The main soil property for these sites is a Cr contact at 20 to 40 inches from the soil surface. These areas are most likely to have shallow soils and rock outcroppings. The water movement on these areas is through the soil with reappearance as streamflow downslope in the colluvial material. The movement of water is largely by

unsaturated flow except in thin layers of soil material directly above rock contact flow surfaces. Runoff is slow except for the rock outcrop areas.

General Notes on Watersheds #34 and #36

The geology of watershed #34 is somewhat different than that of watershed #36. Watershed #34 contains mica gneiss at sites NC113012, NC113013 and NC113016 and hornblende gneiss at site NC113013. Watershed #36 contains interbedded mica gneiss and granite gneiss.

The geology of watershed #36 was more uniform than that of Watershed #34. Sites NC113017, NC113018, NC113019, NC113020, and NC113021 have interbedded mica gneiss, hornblende gneiss, and granite gneiss.

In general, soils in watershed #34 contained more mica than did soils in watershed #36.

SITE SELECTION FOR WHITE OAK RUN WATERSHED

(1) Sites VA165001 and VA165004 were selected to represent floodplain and small terrace positions, respectively, along White Oak Run. These sites varied in elevation and vegetative cover. These soils have skeletal layers to a depth of 60 inches and may have saturated flow sometime during the year. Saturated flow is not reflected in the profile by the presence of low chroma mottling, i.e., less than 2. These soils have ochric epipedons and cambic B horizons.

(2) Site VA165003 was selected to represent the stream headwater soil. Most all of the headwater soil is represented by this site. There is very little vegetation difference between this site and VA165002 or VA165005 although they vary in elevation. Soils are 20 to 40 inches to bedrock and are skeletal. This site represents unsaturated flow. Aspect influences vegetation for the most part. This soil has an ochric epipedon and there was some question as to whether it has an argillic.

(3) Sites VA165002 and VA165005 were selected to represent the backslope positions. Soil types differed mainly because of varying geology, i.e., sandstone and phyllite, respectively. Site VA165002 represents the primary headwater soil which occupies elevations of 2,200 feet and above. Runoff from these soils is carried by Luck Hollow which empties into White Oak Run. Below this 2,200 feet elevation, the soils are very similar to VA165003. It was indicated that stream chemistry varies between White Oak Run and its tributary, Luck Hollow. Vegetation is similar at each location. VA165002 contains large areas of rubbleland that support no vegetation combined with an extremely stony area that supports mostly Chestnut Oak and pine. Soils are skeletal and depth to bedrock is 20 to 40 inches. These soils have ochric epipedons and cambic B horizons.

APPENDIX D

LETTER TO LANDOWNER

September 16, 1985

Dear Landowner:

One of the most important environmental concerns for our nation is the potential effect of acid rain on lakes and streams. It is crucial to know how many lakes and streams are at risk of being acidified by acid rain in the near future (called, "direct response systems"), and how many are protected by the antacid actions of soil, rocks, and other parts of the watershed ("delayed response systems"). To find out, the U.S. Environmental Protection Agency is looking at a large number of lakes, streams, and watersheds in the eastern United States. The Soil Conservation Service is cooperating in this project by describing and sampling selected soils on these watersheds. The soil samples will be analyzed to see how much protection from acid rain the soils give to the lakes and streams.

We are requesting your assistance in this project. Your property contains a soil type that is important for us to describe and sample. This would mean digging a hole in the ground. This hole might be up to 5 feet deep but most likely will be shallower than that. The sampling crew will describe the soil and remove a small amount for chemical analysis. Then they will fill in the hole after they are finished.

It is, of course, totally up to you whether you will permit us to sample the soil on your property. We hope you will choose to assist us in this important project. If you wish, the results of the soil description and analysis will be sent to you when they are available. Simply inform the sampling crew of your desire for this information. The results of the soil analysis will most likely be available next summer.

Thank you in advance for your consideration and cooperation in this matter.

Sincerely,

Technical Director
Direct/Delayed Response Project